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Forest
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General
Technical
Report
WO-48

Advancing Knowledge of Forests and Rangelands

1984 Research Accomplishments

367

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Agriculture

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July 1985

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Foreword

In this booklet you will find more than 50 highlights of our research projects. They are samples of results of the studies that our scientists and cooperators are doing to ensure a better job of resource management in the future. The listing of our research publications beginning on page 59 will give you an even more comprehensive look at the extent and depth of Forest Service research carried on in our eight regional Experiment Stations and the Forest Products Laboratory. (A map of principal research headquarters and field offices is on page 177.)

Our research takes several approaches to solving the problems of future management. Most often we undertake original research by analyzing the problem, experimenting carefully, then testing and applying the findings. Or, in cases where much research has already been done on parts of problems, we may gather and synthesize earlier findings that have yet to be applied. Our research has uncovered new ways to stretch limited management dollars.

Basic research--because it can open whole new areas in the use of natural resources--continues to be an indispensable part of our program. Research in basic biotechnology, for example, may provide us with several ways to use the enzyme that degrades the lignin in wood--an enzyme that has been newly discovered by our scientists and that shows promise for many industrial applications.

The increasing demands on our renewable resources will make innovative research like this more important than ever in managing tomorrow's forests.

R. Max Peterson

R. MAX PETERSON
Chief

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Acknowledgment

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Environment

Fate of Sulfate in Forest Soils

Acid rain is one of the most widely publicized environmental problems in the world. Because sulfates are a major constituent of acid rain, the effects of acid precipitation on forest ecosystems depend largely on the fate of these sulfates in forest soils.

Some encouraging results have been found at the Southeastern Station's Coweeta Hydrologic Laboratory in the southern Appalachians. There, it has been shown that microorganisms in the forest floor and soil rapidly incorporate sulfates into organic molecules. In a continuous process, the organic forms are mobilized to release sulfate, but the rate of incorporation exceeds the rate of mobilization, and there is a net accumulation of organic sulfur in the soil. The process is important because organic forms of sulfur are far less soluble than inorganic sulfates. Thus, the microorganism activity is reducing the supply and mobility of sulfur in the soil to provide a buffer against the impacts of acid precipitation on forest soils in the region.

These findings do not mean that acid precipitation is harmless or that its effects will not be felt eventually. They probably mean that the effects will not be seen as soon as they would be without conversion of sulfates to organic forms.

Searching for the Cause of Lake Acidification

On national forests in northeastern Wisconsin and the Upper Peninsula of Michigan, 5 to 10 percent of the clear-water lakes (the ones not influenced by acid bogs) are acidic, with a pH of 5.3 or less. Many of these lakes are on coarse sandy soils, or on shallow soils over granite bedrock. Such sites offer very little alkaline rock to help offset or "buffer" the effects of acid precipitation. Researchers, land managers, and the general public want to know whether the acidity is natural or the result of acid precipitation.

Scientists have learned that the average yearly precipitation across the northern Lake States changes in pH from a normal 5.2 or more in western Minnesota to an acidic 4.3 or less in central and southern Michigan. To find out the effect of this acid precipitation, scientists at the North Central Station have analyzed data on lake chemistry gathered by the USDA Forest Service over the past 10 to 15 years. They found that when acid rain or snow acidifies a lake, bicarbonate decreases while sulfate increases in relaon to calcium and magnesium. The fact that these changes become more pronounced from west to east, just like the acidity of the precipitation, suggests that one is related to the other.

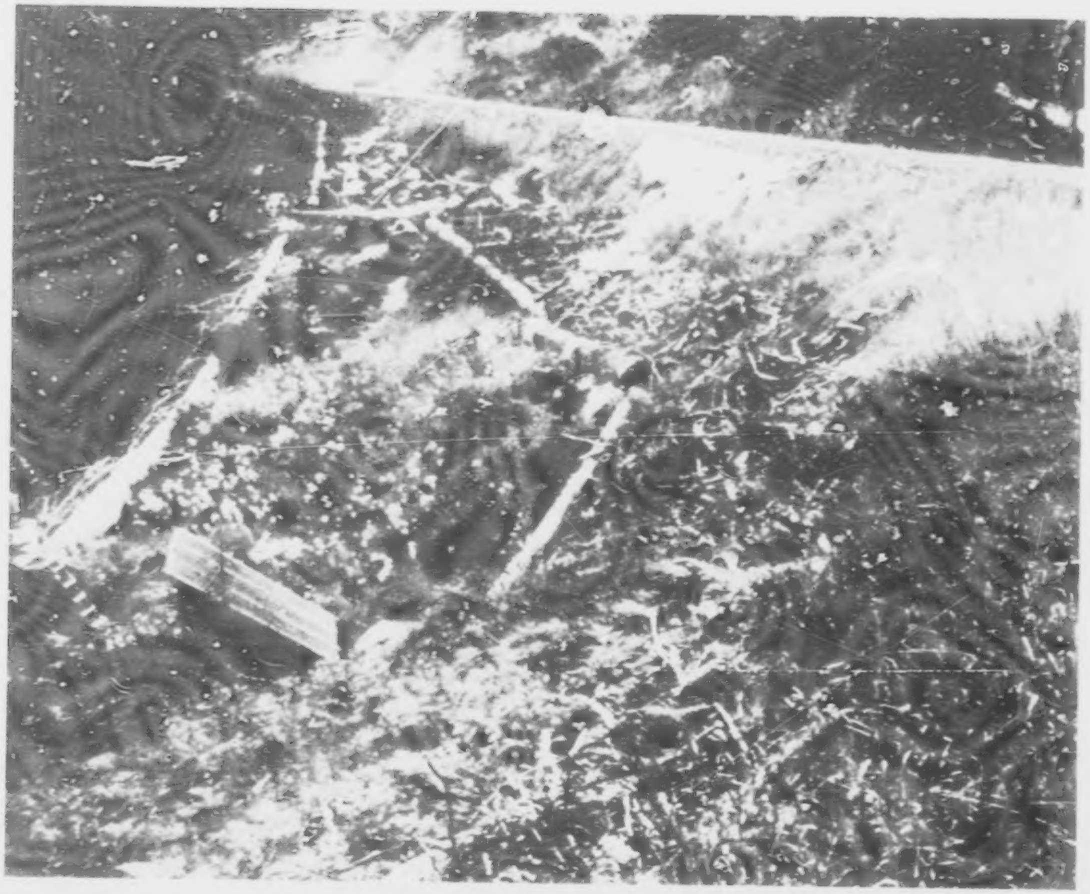
The scientists also projected that if precipitation acidity doubled, about 25 percent of the lakes on national forests in Wisconsin and Upper Michigan would become acidified, together with a small percentage of lakes in northeastern Minnesota and Lower Michigan.

Lake chemistry data are gathered to assess effects of acid deposition on water resources.

Erosion in and around the dirt roads that are typically built in forests is a serious problem in mountainous terrain. If a portion of the road washes away, expensive repairs may be required; even when repair is not needed, the sediment from erosion reaches streams and harms fish. Forest managers need low-cost treatments that will prevent such erosion, and scientists from the Intermountain and Northeastern Stations have been providing them.

The scientists have shown first that no amount of treatment is a substitute for good design and construction. A little extra spent during construction may mean big savings in maintenance.

Once a road is built, three treatments are likely to reduce erosion considerably: grass seeding, application of mulch, and windrowing of cut vegetation on fill slopes. A stand of grass is highly effective in preventing erosion over the long term. Mulch is useful for short periods while vegetation is becoming established. The same is true for the windrows on fill slopes. Once vegetation is established on fill slopes, erosion is likely to be inconsequential. In the meantime, windrows of construction slash offer cheap and effective protection. Use of these treatments was found to eliminate 99 percent of the erosion from bare fill slopes.

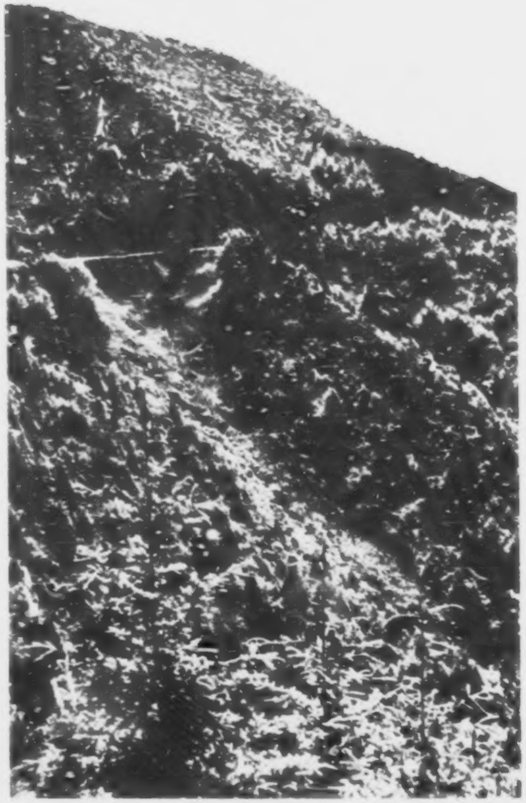


Stabilized fill slope.

Coping With Landslides in West Coast Forests

Landslides are a critical problem in rugged west coast mountains, and timber harvesting can increase the chances of slides on steep slopes. As the roots of cut trees decay, soil strength is reduced. Timber harvesting and road building can change the amount of water available to trigger landslides. Special management considerations appear to be desirable for some high-risk slopes, but first the high-risk areas have to be recognized. Forest Service scientists developed methods for doing so, and they are applying these methods on western national forests.

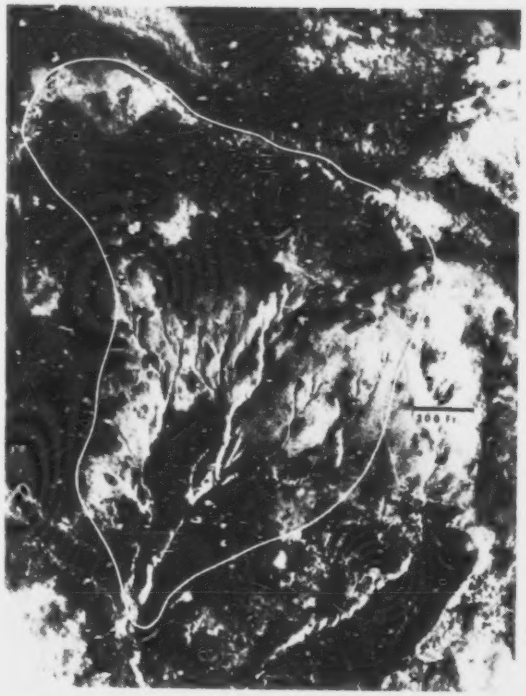
At the Pacific Southwest Station, scientists have analyzed the factors that make landslides likely and developed a mathematical formula that identifies landslide sites with 81 percent accuracy. At the Pacific Northwest Station, scientists have designed sampling techniques for inventorying landslides. So far, more than 400,000 acres on five national forests have been inventoried. Results of the two projects are helping land managers to assess risks and prevent landslides.



Fill slope failure in coast range of Oregon.

Establishing Priorities for Treatment of Gully Networks

Gullies seldom develop randomly on an eroded watershed. Research at the Rocky Mountain Station on gully formation, stream dynamics, and erosional processes has generated a basic understanding of why and how gullies expand into networks. From this understanding, scientists have developed a procedure for setting priorities in gully control. The procedure consists of five steps: (1) determining type of network based on gully types, (2) stream ordering of the network gullies, (3) tallying tributaries of each gully, (4) analyzing stage of development of each gully, and (5) ranking of treatment priorities. With this procedure, land managers can identify critical segments in gully networks. Controlling these segments can buy the greatest amount of gully control at least cost. The procedure is available to land managers as a training film on color video cassette. This training film, along with several others on gully treatment and rehabilitation, has been widely used for training hydrologists and land managers throughout the Southwest Region.



Controlling critical gully segments buys greatest erosion watershed protection at least cost.

A Snow-Slope Stability Index for Assessing Avalanche Potential

A new technique has been developed by Rocky Mountain Station scientists for evaluating snow-slope stability over extensive mountainous areas. The new technique uses ratio testing and probabilities to evaluate existing snowpack stability on a daily basis. This regional stability index, which approximates the probability of slope failure, gives very precise results if avalanche occurrence data are available for a few hundred paths representing a wide range of occurrence frequencies. Stability can be estimated quite well with a much smaller sample of paths, especially in unstable situations when slope failures are most frequent.

The stability index offers the best way now available to evaluate the accuracy of more detailed avalanche forecasting models. In conjunction with a dense spotter network, this technique could provide avalanche forecasters with a more accurate assessment of current stability conditions. The index also has potential for increasing efficiency and effectiveness of avalanche control personnel who must decide when to shoot down threatening snow accumulations at ski areas and along highways.

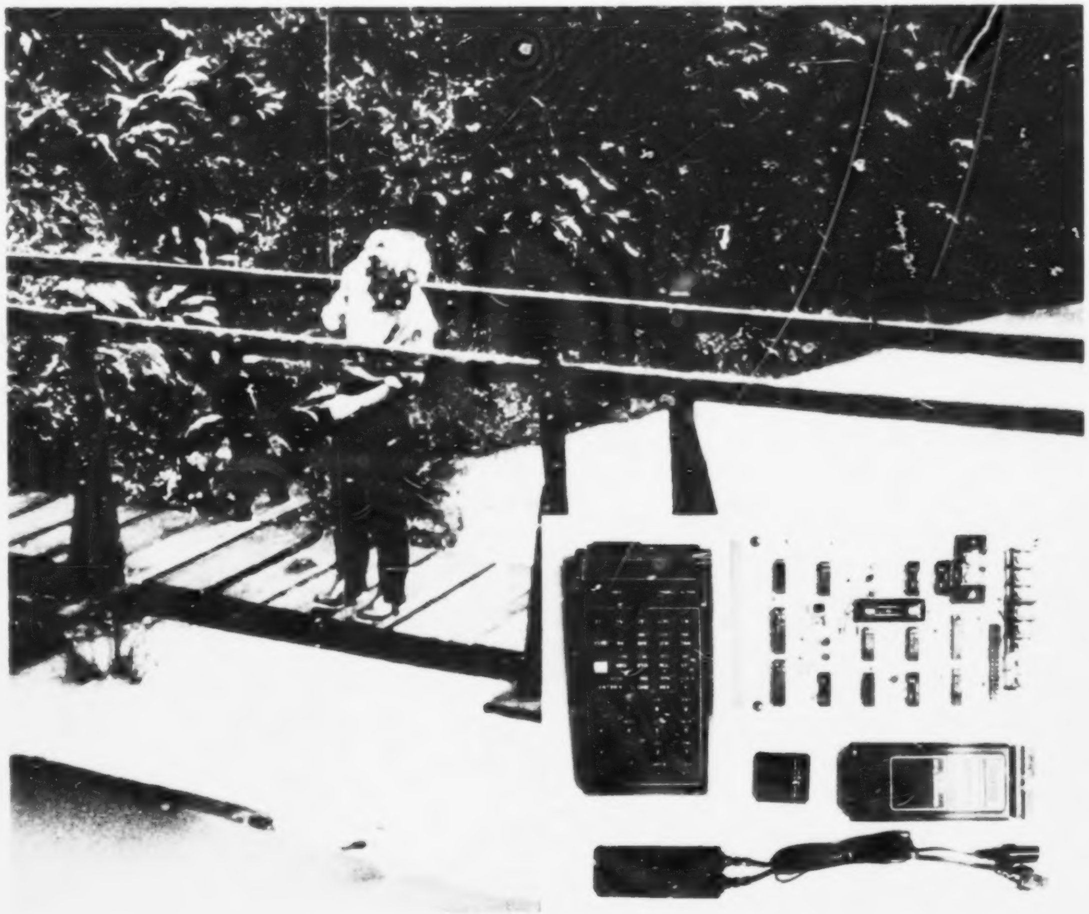
Measuring the Success of Mined Land Revegetation

The Surface Mining Control and Reclamation Act of 1977 mandates establishment of "a diverse, effective, and permanent vegetative cover . . . capable of self-regeneration and plant succession" on all reclaimed coal mined lands. The sampling and analysis methods necessary to meet this requirement have been slow to develop because of a lack of technical and conceptual information. To fill this need, the Intermountain Station has published reviews and analyses of methods of vegetation sampling and of assessing species diversity. Methods most applicable for measuring revegetation success are presented in detail. Reference area selection and sampling schemes are covered in addition to production, cover, and density sampling methodology. A statistical section outlines sample size determination and comparison of reference and revegetated areas. The three most commonly used techniques for measuring species diversity are evaluated. Professionals in industry, agencies, and universities have found these reviews useful in selecting sampling and analysis schemes for measuring the success of revegetation.

Superior Method for Estimating Sediment Discharge

Forest managers concerned with water quality need an accurate, reliable method for estimating sediment discharge. Until now, sampling schemes have not taken variations in streamflow into account and have commonly underestimated sediment discharge by as much as 50 percent. The precision and bias of such estimates were unknown.

Researchers at the Pacific Southwest Station have developed a new procedure that provides more accurate estimates. It is called SALT (Sampling At List Time). Monitoring suspended sediment load in a river with this sampling scheme is done with an automatic pumping sampler and a small battery-powered computer that can sense streamflow and make sampling "decisions." SALT estimators are unbiased, and field and laboratory work are greatly reduced because the method requires the minimum number of sediment samples for any desired level of precision. Although the greatest benefit of using SALT may accrue to those seeking to monitor small streams with highly variable flow, its superior statistical properties should improve any sediment monitoring program.



The old method and the new method (inset).

Deer and Cattle Interactions on Southern Forest Range

For many years, wildlife interests have been concerned about grazing of southern forested range. Their worry was that whatever cattle eat is not available for deer, but recent research by the Southern Forest Experiment Station suggests that cattle are more compatible with deer than generally thought. Cattle and captive deer were observed and their diets recorded throughout the year as the animals foraged in uncut and recently clearcut forests in the mixed pine-hardwood type of central Louisiana.

Seasonal forage selection ratings were developed for 264 plants eaten by deer or cattle. Little diet overlap occurred on forested sites during summer and fall, despite the limited abundance of grass. When cattle were forced to use forested sites during winter and spring, their diets overlapped with those of deer substantially. However, cattle prefer recent clearcuts, where forage is more abundant. Here they eat mostly grasses and grasslike plants (graminoids), while deer consume mostly leaves of woody plants.

These findings are significant; for as forest management intensifies and stand rotation ages decrease, acreages in younger plantations will increase. Without grazing or other management, many of these plantations become almost impenetrable and soon produce little deer forage. Through controlled grazing, it may be possible to utilize the abundant cattle forage that these young plantations produce without reducing deer forage. Regulated grazing could benefit deer by improving accessibility to deer forage, by slowing plant succession, and possibly by increasing production of preferred deer foods such as native lespedezas through reduction of competing grasses and grasslike plants.

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Beaver Ponds Provide Rearing Habitat for Coho Salmon

Small streams are primary rearing habitat for coho salmon in the Pacific Northwest and Alaska. Recent studies by the Pacific Northwest Station in Oregon and southeast Alaska have shown that natural beaver ponds in small streams provide large volumes of nutrient-rich water and produce more and larger coho than nearby streams without beaver dams.

Scientists constructed a 1-acre experimental pond in northwestern Oregon to simulate the complex, nutrient-rich waters of a natural beaver pond. Results showed phenomenal winter and summer growth of young coho in the pond. Coho salmon fingerlings that were introduced to the pond in October increased 2-1/2 times in length and seven times in weight by the following April, when they began their seaward migration. Some coho introduced to the pond as fry in April reached smolt size by July--9 months earlier than their stream-dwelling counterparts.

This research is helping fishery managers develop similar cost-effective coho salmon enhancement projects in the Pacific Northwest and Alaska.

Artificial beaver ponds can rival productivity of natural beaver ponds.

Managing Springs and Seeps for Wild Turkeys

Areas in and around springs and seeps are the most important winter feeding places for wild turkeys in northern hardwood forests of West Virginia. Ground water welling to the surface at springs and seeps produces snow-free feeding areas for turkeys during periods of prolonged snow cover. Also, springs and seeps harbor invertebrates and forage plants for food and collect seeds (mast) from overstory trees. Northeastern Station scientists have developed methods for improving seeps for wild turkeys.

Management should be aimed at developing and maintaining mast-producing hardwoods around seeps. Sawtimber-size hardwood stands need no treatment. Fully stocked pole stands should be thinned to leave mast-producing crop trees free to grow and to reduce canopy cover to about 60 percent. Clearing and planting of food-producing trees and shrubs is an option only where deer populations are low enough to allow growth of the planted stock.

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Intensive management of forests for timber production reduces essential habitat for wildlife that use tree cavities because there are fewer old and decadent trees in these managed stands. Research by the Southeastern and Southern Experiment Stations is defining habitat relationships and developing techniques for accommodating cavity-nesting wildlife in managed stands.

A major goal for recovery of the endangered red-cockaded woodpecker is to provide nesting habitat in appropriate amounts and spatial arrangements to facilitate population increase. Research has shown that red-cockaded woodpecker colony sites are located in relatively open, old-growth forests dominated by pine with a low density of hardwood trees. This is particularly significant in view of the finding that there has been a decline of 13 percent in southern old-growth pine habitats over the past 25 years, and the trend is expected to continue. Nevertheless, definition of how new colonies are formed has provided the first guidelines for the location and distribution of nesting habitat to stabilize populations and facilitate population expansion.

Other research has focused on methods for providing suitable habitat conditions for a variety of cavity-nesting birds. For example, development of a technique for inoculating selected individual pines with a wood-decay fungus could be used to make relatively young trees suitable for cavity excavation. Similarly, experiments with southern red oak have resulted in techniques for treating trees to permit growth of heartwood and sapwood-decaying fungi, conditions necessary for woodpecker nest-cavity excavation.

This research is helping Forest Service managers to meet requirements of the Endangered Species and National Forest Management Acts.

Red-cockaded woodpecker.

The Rocky Mountain elk is the most important big game species in many western national forests. Wildlife biologists predict influences of timber sales on elk habitat on the basis of changes in cover and forage and road densities. From these predictions, guidelines have been produced for land managers to plan timber sales.

Wildlife scientists of the Intermountain Station have now completed field tests of these guidelines in forests of Montana and northern Idaho. On 11 study areas, differences in elk habitat were estimated by using the guidelines. All study areas were located in productive elk habitat with only minor differences in habitat quality. In general, observed elk density closely correlated with the guidelines.

Prairie Dog Control Doesn't Pay

Prairie dogs eat grass, and so do range cattle. Cattle provide steaks and hamburgers, and support for rural economies. Prairie dogs do not. Ranchers, therefore, do not like prairie dogs. But is it profitable to poison the rodents in their sprawling "towns"?

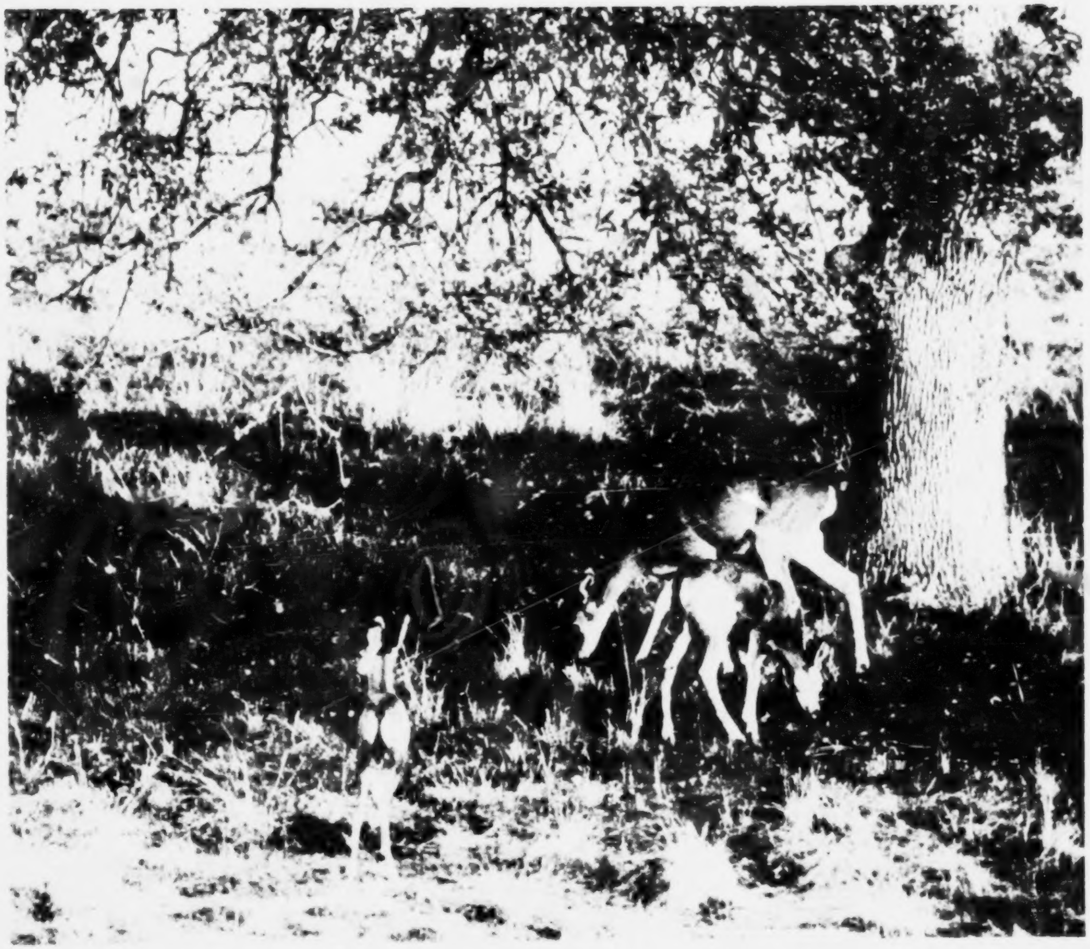
In an effort to answer this question, Rocky Mountain Station researchers in Rapid City, SD, analyzed the benefits and costs of poisoning black-tailed prairie dogs with zinc phosphide. They considered only the benefits from increased grazing capacity for cattle.

The results may give comfort to prairie dogs, which repopulate an area too fast to make control economically feasible. If the annual population growth rate were 5 percent, it would take more than 20 years to recover the control costs through forage increases. Because prairie dog populations increase at a rate of 20 to 30 percent a year, control to capture more forage for cattle is a losing proposition.

Does Habitat Improvement Always Work?

The number of mule deer in the western Sierra Nevada of California has declined to a fraction of its peak in the late 1950's, despite large investments in habitat improvement projects. Research by the Pacific Southwest Station on the North Kings deer population has shown that forage quantity is adequate on winter, migratory, and summer ranges for both deer and cattle. Females are healthy and have a high reproductive rate.

Populations are declining because of heavy fawn mortality. In an intensive study using radio transmitters, annual fawn survival rate was estimated at only 27 percent. Nearly 90 percent of the mortality was attributable to predation by coyotes, black bears, bobcats, and mountain lions. Mountain lions alone accounted for two-thirds of the known predator-caused deaths. These findings indicate that habitat improvement does not necessarily increase numbers of deer in the North Kings population. There population increase appears to depend on reducing fawn predation, at least until there has been a significant increase in deer numbers.



Deer food here is plentiful; predators limit deer numbers.

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Improving Range and Wildlife Habitats

Millions of acres of arid and semiarid rangeland in the Western United States are in fair to poor condition. Often the arid nature of the sites makes improvement difficult. For years, scientists have been studying the problems associated with range and wildlife habitat improvement, and they have made significant progress.

That progress is summarized in the proceedings of a recent symposium held by the Intermountain Station. Various shrubs, broadleaf herbs, and grasses have been developed to improve wild-land sites, and methods for establishment have been perfected. The inclusion of selectively adapted plants, coupled with changes in management of range and wild-land sites, can do much to restore productivity. The methods for doing so are described in the symposium proceedings, which are entitled "Managing intermountain rangelands--improvement of range and wildlife habitats" (General Technical Report INT-157).

If you are providing a service, the best way to find out how well you are doing is by asking the clients. This simple rule is ignored for at least two reasons: (1) the often mistaken assumption that the desires of clients are already known, and (2) an appreciation of the difficulties involved in accurately surveying public opinion. North Central Station recreation scientists have developed a guide to help river managers learn more about river users.

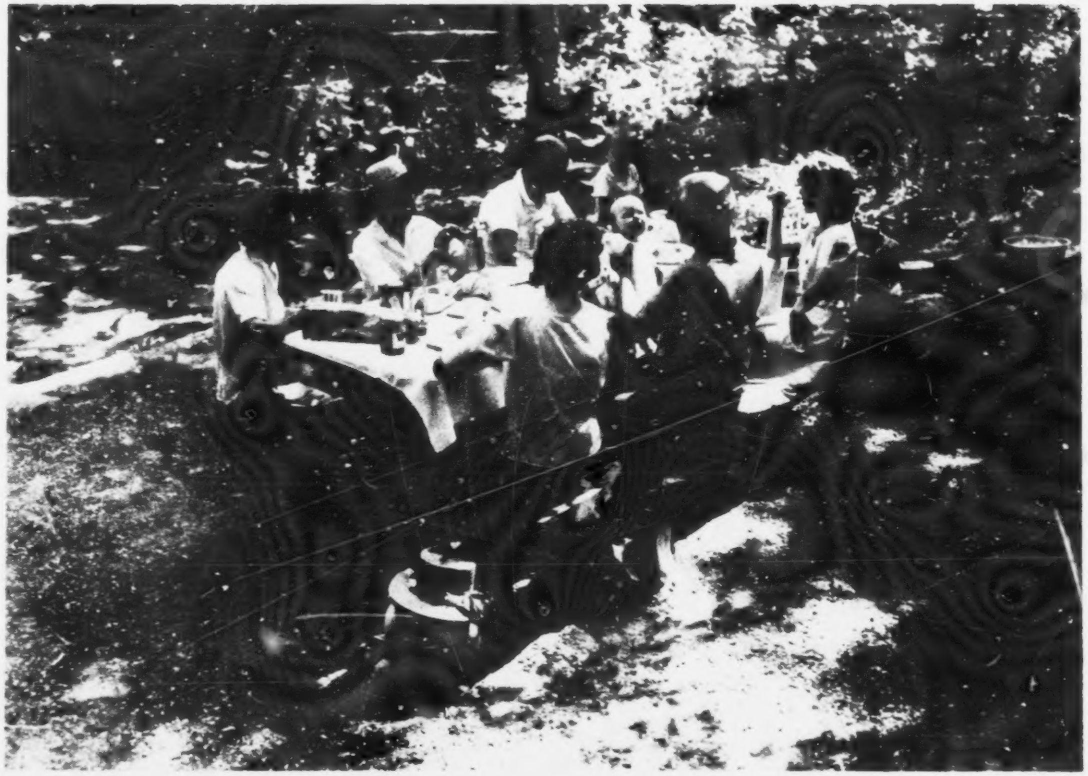
River managers now have a method at their disposal for incorporating client preferences into their resource allocation decisions. The guide includes a set of standardized questions for surveying people taking float trips. Instructions for asking the questions and examples of interpretation of answers are provided.

Predicting Use of an Urban Forest Recreation Area

As a major provider of outdoor recreation in the United States, the Forest Service has developed expertise that is not available to smaller organizations. Therefore, whenever it is practical to do so, Forest Service recreation experts share their knowledge with others. Scientists at the North Central Station have been working with the Forest Preserve District of Cook County, Illinois, to help predict the use of the forest preserve on any particular day of the year. This kind of information is needed to make decisions about site design, rules and regulations, and scheduling of maintenance and law enforcement.

The station scientists have devised a way to predict use based on the day of the week, the month, and the weather. A separate use prediction model has been developed for each of the eight entrance roads into the forest preserve, and computer programs have been developed to estimate use.

As a result of these use predictions (1,641,000 visits a year on the eight entryways), traffic control has been changed and new roads have been planned. Maintenance and law enforcement are being reviewed, and the daily estimates will guide the scheduling of any new construction. The techniques applied here could be applied in many other high-use recreation areas.



Social programs like the Youth Conservation Corps (YCC) have accomplished a great deal of important work on national forests, but what about their effects on the youths themselves? Are the programs providing skills and improving attitudes and behavior of participants? Social scientists from the Rocky Mountain Station and Colorado State University analyzed YCC participants 26 months after the end of the program in an effort to answer these questions.

The YCC program was ideal for the study because participants could be chosen randomly from those who applied. It was statistically valid, therefore, to compare the skills and attitudes of recent participants with those of unsuccessful applicants. In this manner the scientists measured YCC-caused changes in 36 types of benefits related to socially desirable skills and attitudes.

As expected, participants knew more than unsuccessful applicants about conservation, environmental problems, and natural resource management. Perhaps more important, they also scored higher on benefit scales related to learning to work more efficiently, participating in group efforts, accepting and getting along with people of other races, and having confidence in their ability to find and hold jobs.

Whether these gains are sufficient to justify the public programs is a matter of opinion. In any case, the research findings will be useful in designing similar programs in various types of public and private youth camps.

Gaining personal confidence and learning to work with others were major benefits to YCC youths.

Insects and Disease

Spruce Budworm Research Completed

The Canada/United States Spruce Budworms Program (CANUSA) was completed on September 30, 1984. Scientific information of worldwide interest generated by the research sponsored by CANUSA is appearing in hundreds of journal articles and technical papers intended for scientific and technical audiences. In addition, user-oriented publications for forest managers and pest management specialists are being distributed to facilitate application of program results. The program also sponsored workshops, technical conferences, symposia, tours, and other educational sessions in special efforts to get new and improved information into training programs for silviculturists and entomologists.

When CANUSA began in 1978, the most devastating spruce budworm outbreak in forest history covered about 125 million acres in eastern Canada and Maine. Since then, the epidemic has stabilized, even subsided in some areas. Clearly CANUSA did not alter the course of the epidemic. The program did, however, influence how eastern forest managers deal with the problem: (1) acreage sprayed in control programs was reduced by application of "targeted harvesting/targeted spraying" by improved aircraft navigation, remote sensing and photo interpretation, and refined hazard-rating guides; (2) use of microbial insecticides based on *Bacillus thuringiensis* increased dramatically as the result of demonstrated greater reliability from higher concentrations and improved formulations of the pathogen; (3) management planning improved from application of a wood-supply model and a budworm impact study; (4) greater utilization of budworm-threatened and damaged balsam fir was made more attractive by information on longer utility life, potential for use in panel products, and improved harvest and transport design; (5) an efficient moth-population monitoring system that used pheromone-baited traps was developed and demonstrated, and an automated egg-mass counter was developed; and (6) procedures for hazard-rating spruce-fir stands and silvicultural prescriptions were provided.

For western forest managers, the program has: (1) developed a package of computer models that enable forest managers to integrate information about budworm development and population trends for specific forest stands to project the effects of defoliation; (2) developed more efficient and precise sampling methods for three life stages (eggs, larvae, and pupae) and refined and evaluated the automated egg-mass counter; (3) identified three major forest zones in the West with different outbreak frequencies, and developed methods for predicting outbreak frequency from general climatic data; and (4) developed five methods of hazard-rating stands for susceptibilty to budworm based on aerial surveys, a climatological model, photo interpretation, ground-survey models, and a generalized indexing model.

CANUSA's timely delivery of new information and technology has helped many managers recognize that the budworm problem is a continuous but manageable aspect of management of spruce-fir forests.

Feeding shelter of spruce budworm.

Effects of Atmospheric Pollutants on Trees and Forest Ecosystems

Recent research on the effects of air pollutants on forested ecosystems has highlighted the sensitivity of various tree species and ecosystems to air pollution or to the secondary effects of those pollutants.

The decline and mortality of red spruce in the Northeast has received wide attention because of the possible involvement of atmospheric deposition. A 1983 survey revealed that the root pathogen Armillaria mellea is associated with this decline at low elevations but is virtually absent from high-elevation forests, where the decline is most severe. The lack of this root pathogen at high elevations may be linked to the increased air pollutants found at higher elevations, particularly lead. A cooperative study between the Northeastern Forest Experiment Station and Yale University showed that Armillaria is sensitive to lead. In high-altitude soils with high concentrations of lead and in low-altitude soils with added lead, production of the shoestringlike structures of Armillaria that grow through the soil from diseased to healthy trees was significantly less than in untreated soils. There may also be an interaction between lead and acidity (pH); lead is more inhibitory when pH is lower (more acid).

Investigators have examined the effects of ozone air pollution on trees and forest ecosystems in the mountains of Virginia and in the mountains east of Los Angeles in California.

In Virginia, ozone and its photochemical precursors are the major pollutants. Ozone concentrations are higher during the growing season (April to October).

Eastern white pine was the first species to show symptoms, including growth loss, reduced needle length and retention, and chlorosis. Recent investigations in the Shenandoah National Park by Northeastern Station scientists have reconfirmed that ozone concentrations increase with elevation throughout the Blue Ridge Mountains. Leaf injury of sensitive native forest tree species, grasses, sedges, and forbs is greater at higher elevations.

In the San Gabriel and San Bernardino Mountains east of Los Angeles, the relative sensitivity of various conifer seedlings to photochemical oxidant air pollution has been measured by scientists of the Pacific Southwest Forest and Range Experiment Station. The three most susceptible species were western white pine, ponderosa pine, and Jeffrey pine; the two least affected were sugar pine and Douglas-fir. Because there were considerable differences in susceptibility within species, selective breeding could produce more resistant varieties. These results will be used to identify species best suited for areas of high air pollution, such as the Los Angeles basin.

Northeastern Station research shows that the effects of pollutants on photosynthesis are complex. The rate of photosynthesis increases as carbon dioxide concentration increases, but it decreases with increases in sulfur dioxide and ozone. The net change in this process, which is vital to plant growth, depends on the relative concentrations of pollutants.

Air pollutants are killing trees in some places.

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New Christmas Tree Pest Manual Published

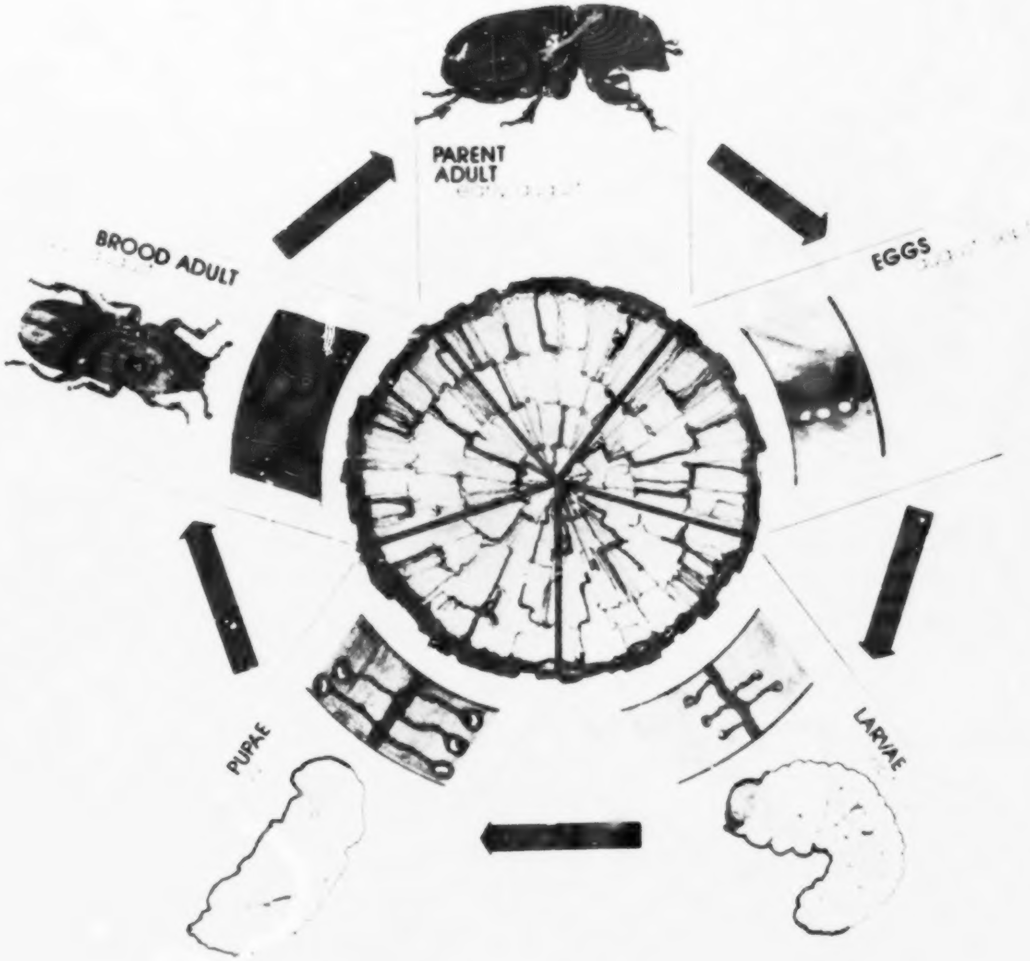
To most people, pests are a plain nuisance. But to people who grow Christmas trees, pests that injure evergreens are a multimillion-dollar threat. In the Lake States, where one-third of the Nation's Christmas trees are grown, pests can take a $30 million bite out of the profits each year. Growers must be able to identify the pests and know how to control them. Until now, the information they needed was scattered in many scientific publications--difficult to find and to understand.

The North Central Station and the Northeastern Area, State and Private Forestry, compiled more than 10 years of pest research in one practical, easy-to-use handbook--the "Christmas Tree Pest Manual." Color photographs and descriptions of 70 major Christmas tree pests will help growers, nursery operators, horticulturists, Extension agents, foresters, and students to quickly identify pests in the field. Also included are cultural, biological, and chemical controls that can help reduce or prevent costly damage.

A Model to Estimate the Rate and Amount of Lodgepole Pine Losses to the Mountain Pine Beetle

Unchecked epidemics of mountain pine beetles can kill most merchantable lodgepole pine in a stand within 3 to 7 years. A model to simulate the rate and amount of these losses to the mountain pine beetle has been developed by the Intermountain Station. Simulating tree losses with the model helps the land manager focus attention on stands where high tree mortality is likely. These stands can be harvested or treated silviculturally before a beetle outbreak occurs so that tree losses are prevented or minimized.

The model is based on ecological relationships of mountain pine beetle and lodgepole pine as determined by comprehensive research at the Intermountain Station on population dynamics of the beetle. The model was verified in 2,500 stands and now is used to simulate losses to the mountain pine beetle in all lodgepole pine stands on Federal and State lands over a wide area.



Life cycle of mountain pine beetle.

New Insecticide for Termite Control

In many parts of the world, wood structures and products must be protected from subterranean termites. Until recently the only insecticides known to provide reliable long-term protection when applied to the soil around and under structures were the chlorinated hydrocarbons aldrin, chlordane, dieldrin, and heptachlor. Controversy over the use of these materials has led Southern Station scientists to search for alternative termite control chemicals. What was needed was a safe chemical that would stay in the soil where it was placed, preventing termites from passing through the soil and into a structure.

In long-term field trials, just such a chemical was identified. Called permethrin (Pounce®), the material is a synthetic pyrethroid. It has performed very well in field trials, and it has been registered by the Environmental Protection Agency for use against termites. Among registered termiticides, it has the lowest mammalian toxicity. Pounce is only the fourth termiticide to be registered in over two decades.

In addition to proving out the new insecticide, Forest Service termite research workers have improved the popular bulletin on biology and control of termites. Home and Garden Bulletin 64, "Subterranean Termites--Their Prevention and Control in Buildings," tells how to recognize termites and their damage and how to prevent that damage. All-new color photographs and illustrations make the subject easy to understand. This bulletin can be purchased from the Superintendent of Documents, U.S. Government Printing Office.

Without control, subterranean termites can make short work of wood on or near the ground.

New Strain of *Bacillus thuringiensis* for Use Against Forest Insect Pests

Bacillus thuringiensis (B.t.) is a bacterium that produces a naturally occurring disease of leaf-chewing insect pests. Since 1970, a B.t. strain designated HD-1 has been marketed in various formulations as a microbial insecticide. It is now competitive in price and effectiveness with chemicals for control of leaf-chewing insects. A new strain of B.t. was isolated from spruce budworm larvae by a Northeastern Station scientist. This strain, called NRD-12, is being extensively field tested in the United States and Canada.

Taxonomically, NRD-12 is closely related to HD-1. The similarity between the strains extends to some pathogenic characteristics. The cabbage looper, the insect designated as the universal standard insect used to assess and standardize the potency of B.t. strains and formulations against lepidopteran pests, is equally susceptible to both strains of B.t. The NRD-12 strain is, however, two times more potent than HD-1 against the spruce budworm, one of the most destructive native forest insect pests in North America. The rate of kill of NRD-12 when used against the budworm is nearly twice as fast as that of HD-1. This insecticidal characteristic is of major importance when foliage protection is of prime consideration. The characteristic of this new strain is not limited to these two pests. The gypsy moth, a major forest insect pest of the Northeastern United States, is nearly four times more susceptible to NRD-12 than to HD-1.

Large field tests of NRD-12 are in progress. If the strain performs as well there as in the laboratory, it may soon replace HD-1. NRD-12 has been registered with the Environmental Protection Agency by a major manufacturer and will soon be commercially available.

Gypsy moth larvae.

Aid for Identifying Wood Decay Fungi

Decay of wood is caused by many kinds of fungi, and the damage they cause varies considerably. Control of decay, therefore, can often be improved if you know what fungus you are dealing with. In addition, accurate identification is vital in the newly emerging uses that harness decay for useful purposes. Unfortunately, many fungi that decay wood have been indistinguishable because available descriptions were inadequate.

Researchers at the Forest Products Laboratory have published a book that addresses this problem. The book, "Monograph on Phanerochaete," describes and illustrates the genus Phanerochaete, with its 47 species of important wood-decaying fungi. It is published in Mycologia Memoirs. One of the identified species is P. chrysosporium, which is used throughout the world for controlled delignification and has potential as a decoloring agent for the kraft bleaching process.

The book gives similarities and distinguishing characteristics of each species. The nomenclature is clarified where necessary, and the species that do not belong in the genus are excluded. Researchers working on wood decay in forests or forest products will be able to make positive identifications of the decay fungi being studied.

A plant pathologist identifies a decay fungus by its microscopic structures.

Fire and Atmospheric Sciences

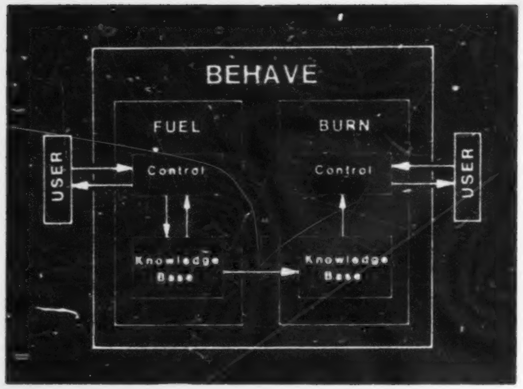
Predicting Fire Behavior by Computer

The person who wants to control a wildfire or plan a fire to improve forest or rangeland conditions must understand how that fire is likely to behave. The type and amount of fuels, the weather, the fuel moisture, and the topography determine a forest fire's intensity and rate of spread, but the relationships among these variables are complex. That is why Intermountain Station scientists have developed a computer program named BEHAVE for predicting fire behavior. BEHAVE incorporates the results of years of research on fire behavior into an easy-to-use and versatile system.

BEHAVE is designed to be what programmers call user-friendly. That is, it prompts the user for information about fuels, weather, and the fire situation. This feature minimizes the learning time and greatly aids users unfamiliar with computer terminology in language familiar to them.

Such programs eliminate the need for the researchers to simplify complex relationships for the fire manager. The equations expressing these relationships are solved almost instantly by the computer, giving the fire manager the best available predictions.

Training in the use of BEHAVE has been provided to fire managers throughout the Forest Service and to their counterparts in the Bureau of Land Management, the Bureau of Indian Affairs, the National Park Service, and the Fish and Wildlife Service, as well as several State organizations and universities. One of BEHAVE's first major applications was during a rash of large fires in Montana in August 1984. Money saved in suppression costs on one 23,000-acre fire near Helena more than paid the development costs.



Underburning May Reduce Productivity in Ponderosa Pine Forests

It is widely believed that prescribed fires of low intensity beneath trees 25 feet tall or more increases their growth. Such burning, it is said, removes competing vegetation and increases supplies of water and nutrients for the trees. You can imagine the surprise of Pacific Northwest Station scientists, therefore, when they examined the growth after some fires under ponderosa pines in the interior West. Unexpectedly, they found that trees grew more slowly during the first 4 years after the fires than before. Height growth was down 18 percent and the increase in stem cross-sectional area (called basal area) was down 16 percent.

At this point, the scientists are unsure of the causes for the decrease in growth, so they are conducting additional studies.

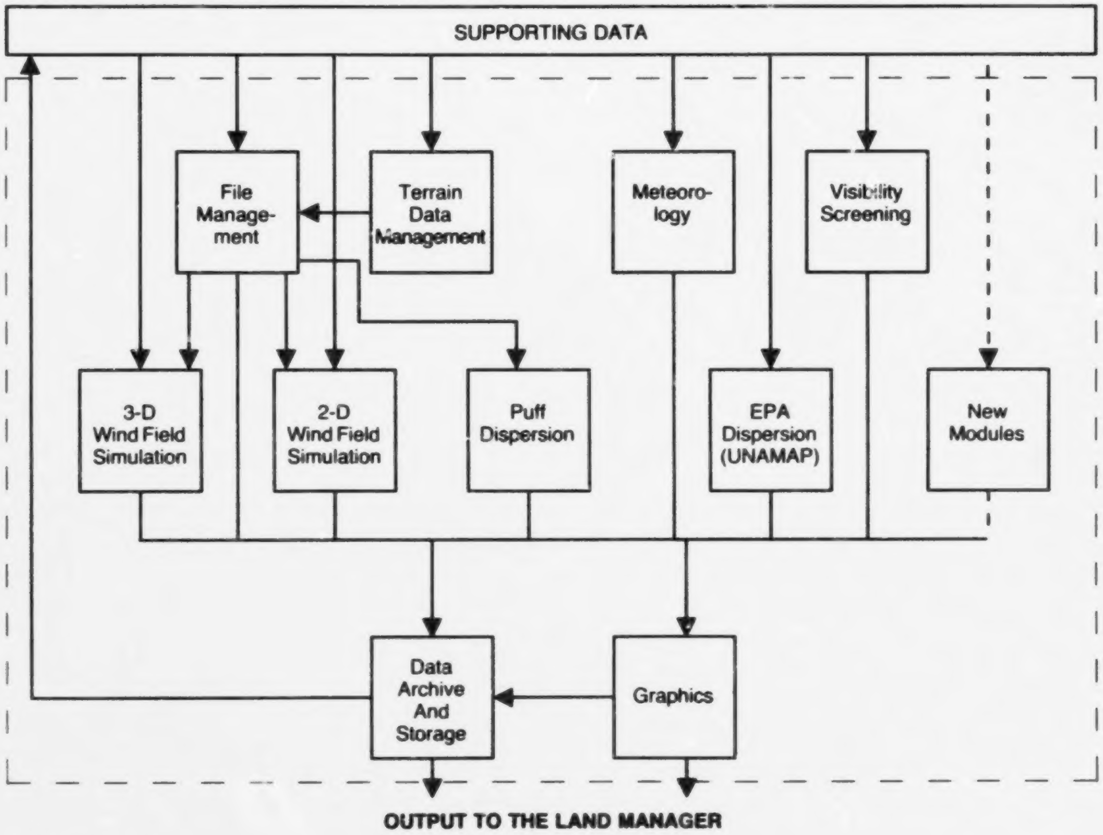
TAPAS: Topographic Air Pollution Analysis System

The Clean Air Act requires Federal agencies to consider the quality of air in their management practices, especially near wilderness areas. Predicting how and where winds will carry various kinds of pollutants, particularly over rough terrain, has been a nearly insurmountable task. The Topographic Air Pollution Analysis System (TAPAS) has therefore been developed by Rocky Mountain Station scientists and cooperators to help land managers assess air pollution potentials in mountainous areas.

TAPAS combines a large set of process simulation models (see figure) into an easily understood, user-oriented system. The system of structured files and file management routines allows the user to move data and model outputs between modules.

Terrain data are available for the 48 contiguous States at a resolution of 30 seconds of latitude and longitude. Additionally, there are both two- and three-dimensional wind models that use the terrain data, along with background meteorological data, to generate a wind distribution. A puff-type dispersion model is also fully integrated into TAPAS. It allows calculation of the trajectory and concentration of pollution from various sources. In addition, there are simpler EPA-developed dispersion models that can be used for air pollution regulatory purposes, meteorological data analysis routines, and an extensive set of graphic display programs.

A unique feature of the graphic display programs is that the user is free to adjust the output to any scale map so that direct map overlays can be produced.



TAPAS modules.

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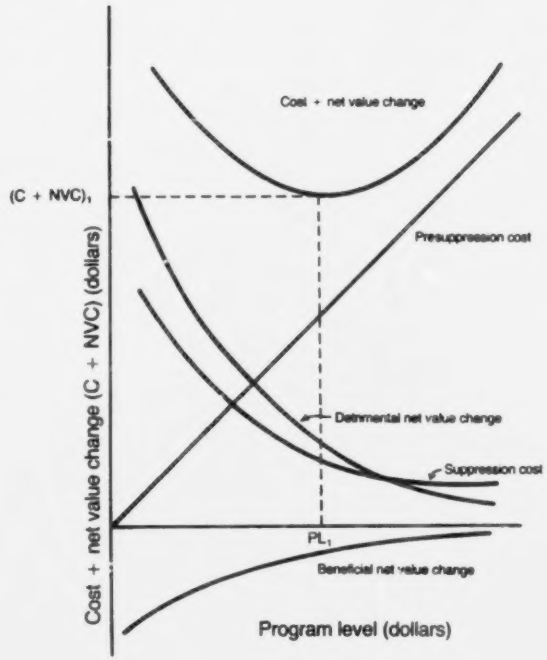
When a major forest fire is burning, the people trying to control it have a lot of factors to consider. They must use available personnel and equipment in a way that promises victory. But economics has a great deal to say about the quantities of people and equipment they can use. The amount of people and equipment used depends on the values that are being protected.

How much damage is a fire likely to cause? This is a question that fire management planners often have to answer, and researchers from the Pacific Southwest Station have been helping to find the right answer for individual sets of conditions. Wildfires sometimes destroy timber stands completely, but more often they cause partial loss and sometimes they even cause improvements. Some of the dead trees often can be salvaged; some of the live ones may have suffered only temporary setbacks. Other trees may not be damaged at all and may grow faster because competition has been reduced. How can all these situations be handled in a single analysis?

The researchers say that calculations of net value change provide the answers that are needed. The value of the stand after the fire can be subtracted from the value before the fire to estimate the net value change. A new procedure is being used in a fire management planning model under development at the Pacific Southwest Station. A sound basis for determining the appropriate values under protection should be one result of this work.



Don't Burn Pesticide-Treated Firewood

Organic pesticides can find their way into firewood in several ways. The bark of trees is sometimes sprayed with insecticide to kill bark beetles. Herbicide is sometimes injected into tree stems to kill them. Is it safe to burn wood contaminated with these pesticides in fireplaces or wood stoves?

The Southeastern Station, in concert with the Cooperative Extension Service at the University of Georgia and the Southern Region of the Forest Service, has examined this problem as part of the National Agricultural Pesticide Impact Assessment Program. Results indicate that such burning can be safe under some circumstances, but it is probably best not to burn such wood indoors. The research was done in a special combustion furnace in which a wide range of burning conditions were simulated.

With rapid flaming combustion, the pesticides were quickly decomposed. Thus, in a well-ventilated fully developed fire in a wood stove or fireplace, one might expect complete decomposition of most common organic pesticides.

When a contaminated wood sample was heated slowly, however, substantial amounts of pesticides were released. The same thing is likely to occur in a damped wood stove or in a fireplace fire that is not fully developed.

Because it is difficult to be sure of the ventilation and temperature in many domestic wood-burning devices, it seems best that wood known to be treated with pesticide should not be burned in the home.

Living More Safely in the Chaparral-Urban Interface

Fires sweep through communities, houses slide down hills, debris flows cover tracts, and flash floods create havoc. These hazards of living in the brush-covered foothills and mountains of southern California often make the front pages of the Nation's newspapers.

In recent years, urban development has extended relentlessly into rural areas around many of the Nation's largest cities. Where the topography is relatively flat and open, this encroachment presents no great difficulty; but where cities are surrounded by steep, brush-covered slopes, development has all too frequently resulted in loss of lives and property.

The brushland sequence of fire, floods, and erosion is particularly common in chaparral areas of southern California. Urban encroachment accelerates the cycle and adds the potential for tragedy.

The Pacific Southwest Station has published a guide, entitled "A homeowner's guide to fire and watershed management at the chapparal-urban interface" (available from Los Angeles County Fire Department or Information Services, Pacific Southwest Forest and Range Experiment Station), to living more safely in the chaparral-urban interface. It describes preventative maintenance measures that should help reduce the damage from fire and flood. The information provided is addressed to homeowners, home buyers, developers, landscape architects, land use planners, wildlife managers, zoning agencies, city and county boards of supervisors, and other interested persons.

Chaparral is a plant community in California that has adapted over millions of years to summer drought and frequent fire. Similar vegetation is found in regions of Mediterranean climate throughout the world. The plants grow dense and luxurious, and when this growth is followed by dry, windy winters, hazardous fire conditions are created.

Research Helps Meet Clean Air Standards

Recent amendments to the Clean Air Act have shifted emphasis from urban to regional air quality and have focused attention on various sources of pollution, such as particulates from prescribed burning. New information from research at the Pacific Northwest Station is helping the Forest Service and the States meet clean air requirements.

Research has developed guidelines for prescribed burning that will help minimize harmful pollution. For example, logged units should be burned as soon as possible after timber harvest. In this manner, production of toxic gases is minimized and formation of particulate matter is reduced. Emissions are lower with a hot, flaming burn than with a smoldering fire. Thus, by controlling the timing and intensity of burn, smoke can be minimized, more burning days are possible, and air quality is improved. Increasing utilization of logging residues can reduce emissions by 17 to 30 percent.

As air resource guidelines are tightened, burning costs per acre can be increased, but this new information gives managers the ability to hold costs down and still meet air quality standards.

Emissions from slash burn are sampled with instruments suspended over the fire.

Timber Management

Silvicultural Systems for the Major Forest Types of the United States

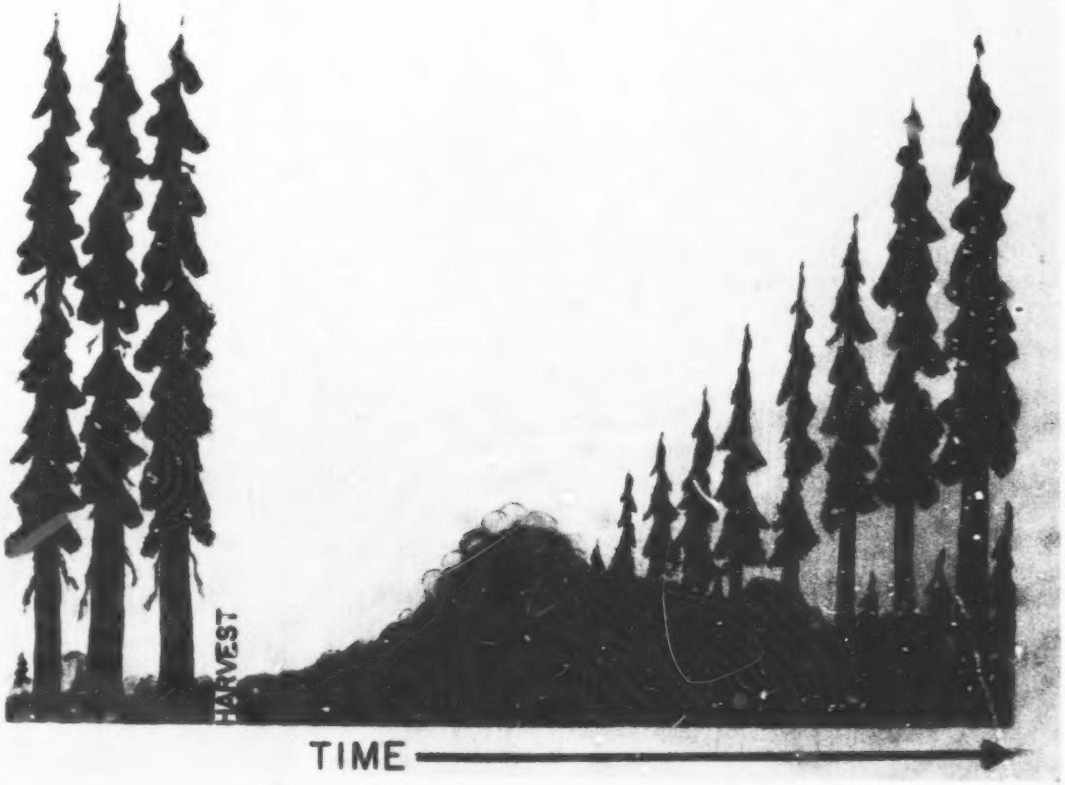
Literally translated, silviculture means the culture of forest trees, and silvicultural systems are the strategies or approaches by which stands of trees in a similar condition are cultured and reproduced. Thus, silvicultural systems are the very heart of forestry. They determine, in a large measure, the goods and services that will flow from forests to a growing population.

The USDA Forest Service has completed work on a new publication, "Silvicultural Systems for the Major Forest Types of the United States." Designated as Agriculture Handbook 445, this publication provides a concise but comprehensive summary of the state of knowledge on management opportunities for each of 48 major forest types in the United States. Copies were provided to all Forest Service employees who make land management decisions. The Handbook is for sale to the general public through the Superintendent of Documents, U.S. Government Printing Office.

Silvicultural Systems for the Major Forest Types of the United States

Lodgepole pine forests are a very important resource of the West. They occupy 18 percent of the commercial forest land in the Rocky Mountains and 5 percent of that in the Pacific Northwest. Stands contain about 65 billion board feet of sawtimber, as well as critical wildlife, watershed, range, and recreational values. Good management of lodgepole pine requires consideration of all these resources. It is especially important to regenerate lodgepole pine stands that have been harvested or decimated by insects and disease.

Scientists from the Intermountain Station have produced a valuable reference for guiding regeneration of lodgepole pine forests, entitled "Ecology and regeneration of lodgepole pine." It summarizes knowledge gathered over several decades on the ecology and regeneration of these forests. Major topics include seed production, disease and insect relationships, soil, competing vegetation, and seedbed preparation. Also included is a handy decision guide for prescribing appropriate practices.



In the old, unmanaged forests of the Southern Coastal Plain, longleaf pine was the dominant species on some 60 million acres. But the loggers came and took the longleaf pine, and the people who came to reforest the South didn't have much luck when they planted the species. Longleaf seedlings have something called the "grass stage"--a period of several years when nothing can be seen above ground but needles and a bud. During this period, the seedling is developing a deep root system; but while it is doing so, competing vegetation is also developing. As a result, longleaf plantations often failed and loblolly and slash pines were planted where longleaf once predominated.

The species did not achieve its status by accident, however. It is extremely resistant to fire, fusiform rust, and some troublesome insects. In addition to these attributes, longleaf pine has good stem form, high wood density, and a respectable growth rate that appears to be sustained to greater tree ages than in other southern pines. That is why many foresters have sought information on successful planting and natural regeneration of the species.

Scientists from the Southern Region of the Forest Service and the Southern Station have produced a guide for management of longleaf pine, entitled "Longleaf pine management." They describe improvements in natural regeneration and planting techniques that have solved or bypassed most of the problems associated with the species. These management advances, coupled with the pine's desirable attributes, make longleaf pine worthy of careful consideration as a major species for management in the southern Coastal Plains.

Longleaf pines 5 years after planting.

Forest Habitat Type Classification: What You See May Not Be What You Get

Forests are dynamic systems--constantly growing, constantly changing. Because trees are so long lived, however, it is often hard for people--even trained foresters--to recognize long-term successional changes. Forest habitat type classification helps managers anticipate natural change and, perhaps more important, changes that are likely to result from various management actions.

The concept of habitat type classification is based on the potential natural vegetation on a site, as indicated by current understory and overstory vegetation. The understory species are key indicators that separate one habitat type from another and may also suggest what overstory trees will eventually occupy a site.

Rocky Mountain Station scientists and cooperators have now developed habitat type classifications for most forests in Arizona, New Mexico, and southern Colorado. The system was first described to managers at the North American Forestry Congress in El Paso, Texas, in February 1984. A series of workshops has since been held throughout the Southwest to introduce the system. Foresters using the habitat types will have a better insight into potential productivity of forests they are charged with managing.

Typical forest scene. What will it look like in 50 years?

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Predicting Regeneration Success After Harvest Treatments

Establishing a good new stand of trees after the old stand is harvested is critical for good forest management. Sometimes a minimal effort is all that is required for stand regeneration, and sometimes elaborate measures are called for. The most elaborate plans can fail, and the results are costly. Productivity lost by poor stocking or delays in obtaining regeneration can never be regained, and poor species composition in the new stand has to be accepted throughout the life of that stand. Clearly, forest managers need to know the likely outcomes of their regeneration prescriptions.

Intermountain Station scientists have developed a model for predicting the outcomes of harvesting and site preparation operations in the grand fir-cedar-hemlock ecosystem, which includes the most productive forests in the northern Rocky Mountains. Scientists at the Pacific Northwest Station have developed equations to help decide whether or not to plant after cutting mixed conifer stands in eastern Oregon and Washington. Factors that affect the likelihood of obtaining good stands by natural seeding include aspect, slope, and seedbed condition, as well as the harvesting method--clearcutting or shelterwood cutting.

By increasing a forester's ability to predict natural regeneration, the need for planting can be reduced. Cost savings from regeneration prediction are estimated to be at least $500,000 a year in the Fremont, Ochoco, and Winema National Forests alone.

Guides for Managing Northern Hardwood Forests

Northern hardwood forests are difficult to manage because they contain so many species growing under so many different sets of conditions. Mixed with the desirable cherry, birch, oak, yellow-poplar, and sugar maple are species that sawmills just won't buy. As if that were not enough, managers must also contend with excessive deer populations in many areas, dense understories in other areas, as well as fragile and nutrient-deficient soils.

Ten years of intensive research promise to bring order from the confusion surrounding the prescription of silvicultural treatments for northern hardwood stands. Scientists at the Northeastern Station have developed an orderly prescription procedure. It begins with standardized data collection on understories, overstories, and site conditions. Next comes data processing, which has been simplified by the development of a computer program called SILVAH. From this procedure comes prescriptions that are silviculturally sound and consistent with landowner objectives.

The research advances are also reflected in an updated silvicultural guide for northern hardwoods. Major changes include new stocking guides for even-aged stands, yield tables for even-aged stands, details on cutting methods ranging from clearcutting to group selection, new emphasis on uneven-age management, and valuable economic guidelines.

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Growth Classification Systems for Red and White Fir

Growth classification systems have been developed by the Pacific Southwest Station for red and white fir in northern California. They should contribute to sound long-term management of these two valuable species.

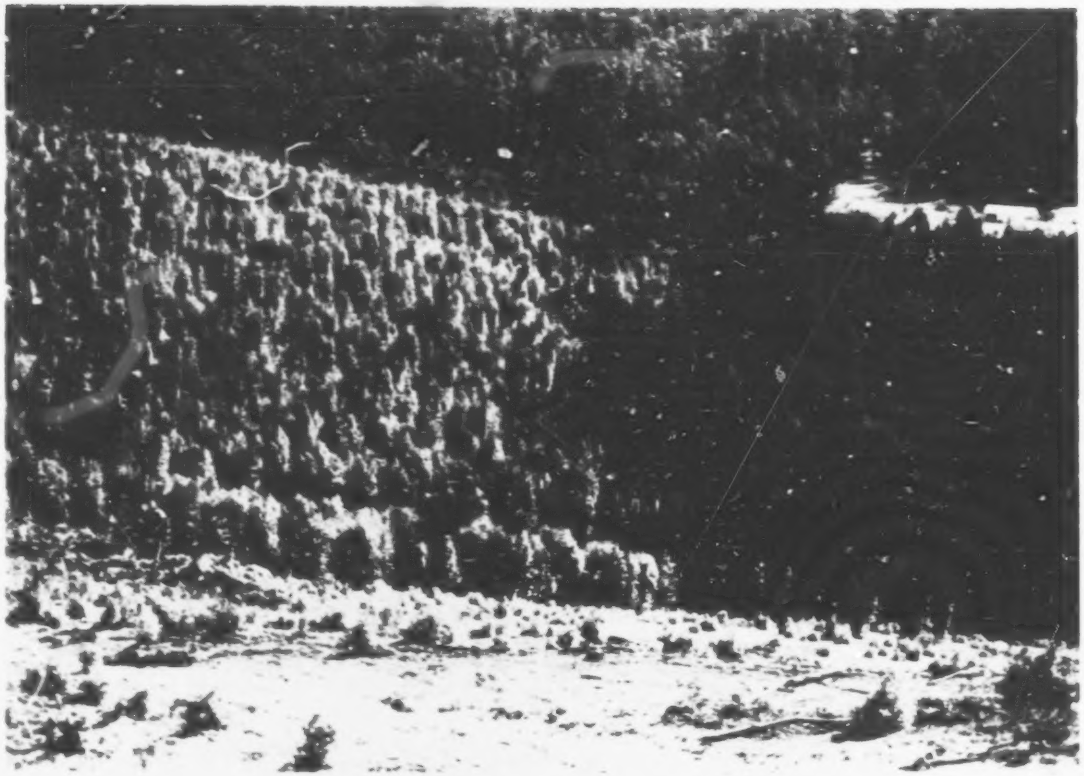
The systems predict future growth from present crown and bole characteristics. They should help in marking stands for partial cuttings designed to maintain acceptable growth in the residual stand. The equations can also be integrated with height growth data to predict stand growth and yield.

These growth classification systems apply to white and red firs at least 4 inches in diameter, growing in all stands except those seriously disturbed in the last decade. They apply to all regions in California from the central Sierra Nevada north to the Klamath Mountains near the Oregon border.

Growing Eucalyptus for Fuel

Eucalyptus are among the fastest growing trees in the world, but it is only recently that this characteristic has interested foresters in California. Since their introduction to the State more than 125 years ago, eucalyptus have been used primarily for landscaping. Now their potential for producing great volumes of fuel in a short time are being appreciated.

To meet the growing interest in eucalyptus, the Pacific Southwest Station, in cooperation with the Cooperative Extension Service, University of California, Berkeley, sponsored a workshop on "Eucalyptus in California" in 1983. Proceedings of the workshop summarize knowledge on this important genus. Scientists and practitioners from California, Florida, Hawaii, Oregon, and France described advanced breeding programs and discussed how their methods and results could be applied in California. They reported on species selection, products, uses, growth and yield, cultural requirements, breeding programs, and propagation techniques. The workshop proceedings serve as a useful reference for those who are considering planting eucalyptus.



Eucalyptus are growing rapidly in experimental planting in California.

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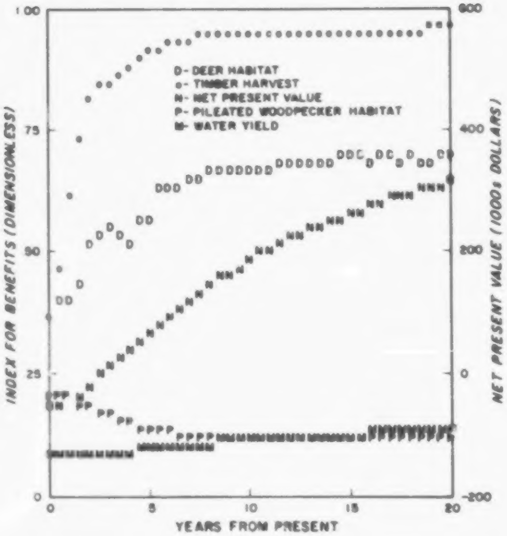
Forest managers must decide when and where to prescribe cultural treatments and harvest timber. These decisions profoundly affect the flow of benefits coming from the forest and form the heart of a forest management plan. In national forests and other areas managed for multiple uses, the decisionmaking process is far from simple, and the computations needed to judge alternatives are very complex. Forest Service scientists have developed computer programs to help in this process.

At the North Central Station, the Computerized Habitat Analysis and Multiple-Use Prescription System (CHAMPS) has been developed. It stores and provides easy access to all the information about a forest property and its resources. CHAMPS also permits the user to project the state of the property into the future and evaluate progress toward goals set in the management plan.

A scientist at the Southeastern Station has applied the principles of system dynamics to forestry situations in a program called DYNAMUSE. After some training, a forest manager can enter information about the relationships between the stand conditions and the production of individual benefits. A computer estimates the production of various kinds of benefits resulting from a particular management approach. Alternative approaches then can be compared on the basis of the benefits produced. Once an approach has been selected, the computerized system helps management to keep the forest in the desired state. Both of these systems can be used on microcomputers.



DYNAMUSE printout.

Resource Economics

Economic Opportunities for Investments in Forest Management in the Southern United States

Recent findings by scientists at the Southeastern Forest Experiment Station demonstrate that there are substantial opportunities in the South for timber management investments that offer competitive economic returns.

They estimated that there are opportunities on 88 million acres for stocking control, stand conversion, regeneration of nonstocked sites, regeneration of hardwoods, and harvest and regeneration that can earn a rate of return of at least 4 percent above inflation. A full 50 percent of the investments were estimated to earn a real rate of return in excess of 10 percent. Investment costs range from a few dollars per acre for timber stand improvement to more than $100 per acre for clearing existing stands and planting desirable commercial species. Treatment of all 88 million acres would cost $4 billion and produce an increase in the annual net growth of timber greater than the entire net annual growth of the region in 1970.

In related research, computer programs were developed to permit rapid calculation of the economic returns on individual treatment areas. Thus, the means are available for rapidly locating the fine investment opportunities that exist.

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During the management of a typical national forest timber stand, some costs associated with the legal requirements for multiple use management are incurred when the timber is sold. At that time, any adverse effects of timber harvesting on other resources are frequently mitigated and opportunities to enhance those resources can be pursued. These activities are often addressed in specific provisions in timber sale contracts, and may influence the "profits" from a Forest Service timber sale--the amount received for the timber minus the costs of the sale. Although timber sales in other organizations often appear to be more profitable than national forest sales in similar areas, the costs for protection of cultural, fish, range, recreation, soil, visual, water, and wildlife resources may account for the difference.

Scientists at the Intermountain and Pacific Southwest Stations have been studying these costs. In Montana and northern Idaho, they find that most timber sale provisions are designed to mitigate adverse impacts of timber harvesting on other resources. The most common sale provisions there are limits on the size and location of cutting units. Limits on location and density of roads are also common, and both provisions strongly influence timber sale costs.

Nationwide cost studies show that limits on the size of the cutting unit strongly influence reforestation costs. Site preparation and planting costs increase substantially there as the size of the unit drops below 75 acres.

The scientists conclude that these costs bear watching to be certain that they achieve commensurate benefits.

Timber sale provisions for protection of wildlife and other forest values can be costly.

Multiple use management of the national forests is required by law, but rational comparison of one management scheme with another requires estimation of the relative values of the benefits that are being produced. Assume, for example, that a change in management is proposed in which elk habitat is markedly improved by reducing the amount of forage available to cattle. The merit of the change depends upon the relative values assigned to cattle and elk. The fact that cattle ranchers and elk hunters are likely to disagree about the relative values does not mean that values should not be assigned. It means that the work is complex and controversial.

The Rocky Mountain Station has published a book, "Valuation of Wildland Resource Benefits," that comprehensively reviews this complex field of natural resources economics. The book provides concepts, theories, and methodology for estimating values of minerals, timber, range, water, wildlife, recreation, and scenic beauty. Another Rocky Mountain Station report outlines problems with lack of comparability among studies over time and suggests solutions.

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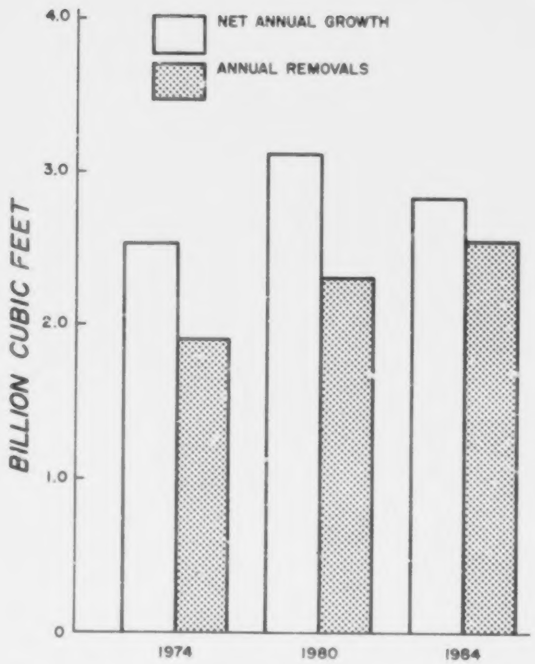
Valuation of Wildland Resource Benefits

Exporting Southern Softwood Lumber: How Small Firms Can Begin

Weak domestic markets for solid wood products have led many small southern softwood lumber producers to look abroad for markets. Some have succeeded and some have not. At a time when the U.S. trade deficit is substantial and growing, exports of forest products could be highly beneficial to the economy as a whole, and Southern Station researchers have determined some of the keys to profitable export of southern softwood lumber.

Major barriers to export by small firms, they find, are an understandable lack of knowledge about foreign trade and a reluctance to enter an unknown field. Particularly for firms within 200 miles of a major southern port facility, the study shows that the time spent learning about export possibilities is well invested. There are two major export markets for southern softwood lumber: Europe and the Caribbean. The European market is dominated by specific tastes in product design and architecture, and it purchases primarily clear lumber. The Caribbean market is dominated by building code and millwork specifications. The study also reveals that small southern lumber producers who are just entering the export market usually benefit by dealing through export merchants. The research identifies methods for locating export merchants for southern softwood lumber and analyzes factors to consider when choosing a particular merchant. Results of this research are being utilized by trade promotion organizations and industries throughout the South to stimulate export of southern pine lumber by small manufacturers.



Without changes in forest practices, increases in pine growth in the Southeast are unlikely.

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Has Pine Growth in the Southeast Peaked?

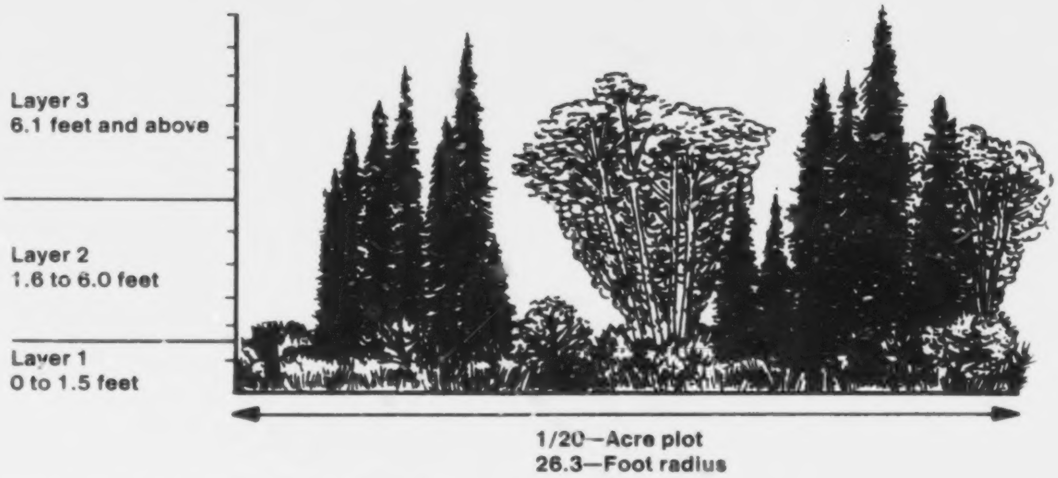
Since the 1930's, forest surveys in the Southeast have recorded and reported increases in the growth of southern pines, because pine stands were being established by natural seeding of abandoned agricultural land. These increases are largely responsible for the enormous expansion of forest industry in the area since World War II because the forest industry there is heavily dependent on southern pines. Recent inventories in the Southeastern States are showing that pine growth is starting to decline.

In Georgia, South Carolina, and North Carolina, inventories in the past 4 years have revealed declines in pine growth ranging from 4 to 48 percent in 8 of 12 Forest Survey units. Resource analysts feel that a primary reason for these declines is the failure of nonindustrial private forest owners to regenerate southern pines after harvesting their timber. Natural reseeding cannot be relied upon to reestablish pine when these stands are harvested, and nonindustrial private owners have shown little inclination to invest in the reestablishment of pine.

A major assessment of the impacts of the pine growth decline is underway. It seems certain, however, that if the forest industry continues to expand in the Southeast, increasing amounts of hardwood will have to be substituted for the fully committed pine resource. Hardwood growth continues to increase there, and most hardwood species are not heavily utilized.

An Efficient Method for Inventorying Understory Vegetation

To meet the increasing demand for integrated resource information, Forest Survey has expanded traditionally timber-oriented inventories to include data on understory vegetation. An efficient procedure for inventorying understory vegetation on forested plots has been developed and is currently being used by Forest Survey in the western Intermountain Region. Combined overstory and understory data can be summarized in a vegetation profile--a graphic display of the horizontal and vertical structure of the vegetation on a plot. This basic information about the plant community can be used for evaluating wildlife habitat, grazing use potential, and land productivity in terms of biomass.



Layers for sampling forest understory vegetation.

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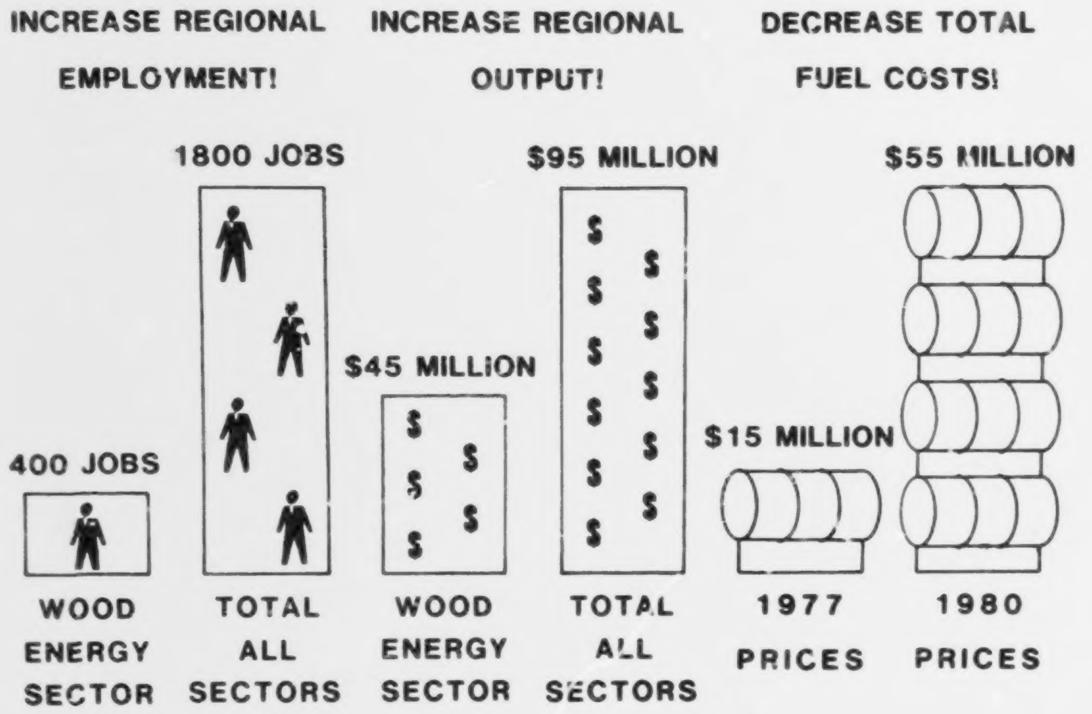
What effect does increased consumption of wood for energy have on prices for wood for industrial products? Based on a study in Wisconsin, scientists at the North Central Station conclude that the effects are very small because fuelwood is coming primarily from different sources than wood for traditional products. In the study, the sources of some 1.9 million cords of round fuelwood were determined. Although 78 percent was taken from commercial forest land, only 15 percent came from growing stock there. About 14 percent came from tops and limbs of growing-stock trees, 46 percent from dead trees, and 3 percent from cull trees and tree sections on commercial forests. The remaining 22 percent was taken from land not classified as commercial forests. These sources, which include cities, villages, pastures, cropland, fencerows, and windbreaks, normally do not supply timber for industrial wood products.

Because wood supplies for traditional industries are not heavily affected, a fuelwood industry could be highly beneficial in many places. In northeastern Minnesota, for example, substitution of locally cut wood for fossil fuels would require the harvest of about 4 million green tons of fuelwood each year. About 400 new jobs would be created in the wood energy industry, and almost 2,000 new jobs would be created in all industries in the area. At the same time, consumers would experience a 10-percent drop in fuel costs.

CUTTING FOSSIL FUEL CONSUMPTION BY 22 PERCENT COULD:



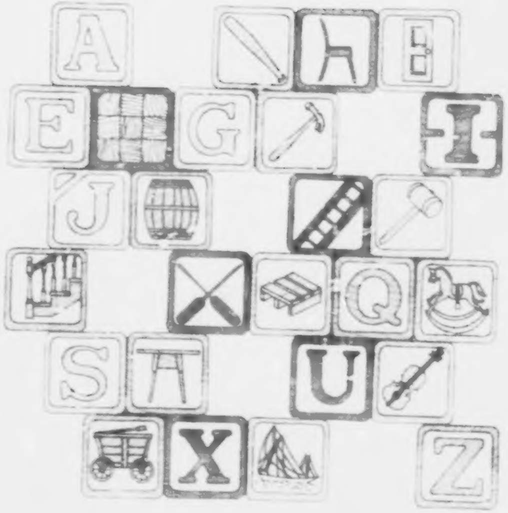
Substituting local wood fuel for imported fossil fuel could stimulate the economy of northeastern Minnesota.

Survey of Wood Used in Manufacturing

More than 22 billion square feet (1-inch basis) of lumber and other solid wood products were consumed in manufacturing in 1977, compared with 17.5 billion square feet in the last Forest Service survey in 1965. Detailed information on the magnitude and changing nature of wood products consumption in U.S. manufacturing was compiled by the Forest Products Laboratory, the Forestry Sciences Laboratory (Princeton, WV), and Forest Resources Economics Research (Washington, DC). These data are vital for researchers, industry analysts, forest land managers, and industry and corporate personnel to adequately assess the needs of the manufacturers and the impact that meeting their needs has on forest resources.

Included in this survey were the quantities of wood products used for materials handling (pallets and skids); packaging; shipping (dunnage, blocking, and bracing); the making of jigs, models, patterns, and flasks used in the manufacturing process; as well as the actual quantity of wood in the final product. Lumber was the product used in greatest amounts.

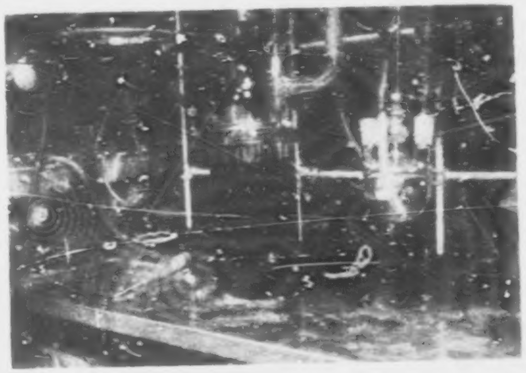
Nearly 75 percent (16.4 billion square feet) of total wood use, on a 1-inch basis, was lumber. This survey is the seventh in a series of periodic studies conducted by the Forest Service. Previous Forest Service surveys were conducted in 1928, 1933, 1940, 1948, 1960, and 1965.

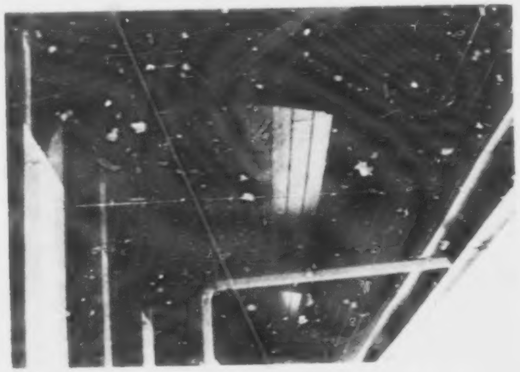


Products and Engineering

Adhesives From Southern Pine Bark

Scientists at the Southern Forest Experiment Station, in cooperation with private industry, have developed a process that enables two-thirds of the resorcinol used in cold-setting adhesives to be replaced by tannins from southern pine barks. Resorcinol is an expensive phenolic compound derived from petroleum. The use of tannins, which are a renewable forest resource, reduces both the cost of these adhesives and also the dependence of U.S. industry on petrochemicals. Currently pine bark is primarily used for fuel at the mill, but after the tannins are extracted, about 80 percent of the bark weight can still be recovered for fuel. The cold-setting adhesives obtained by this new process meet the bond durability requirements for laminated timbers set by the American Institute of Timber Construction.



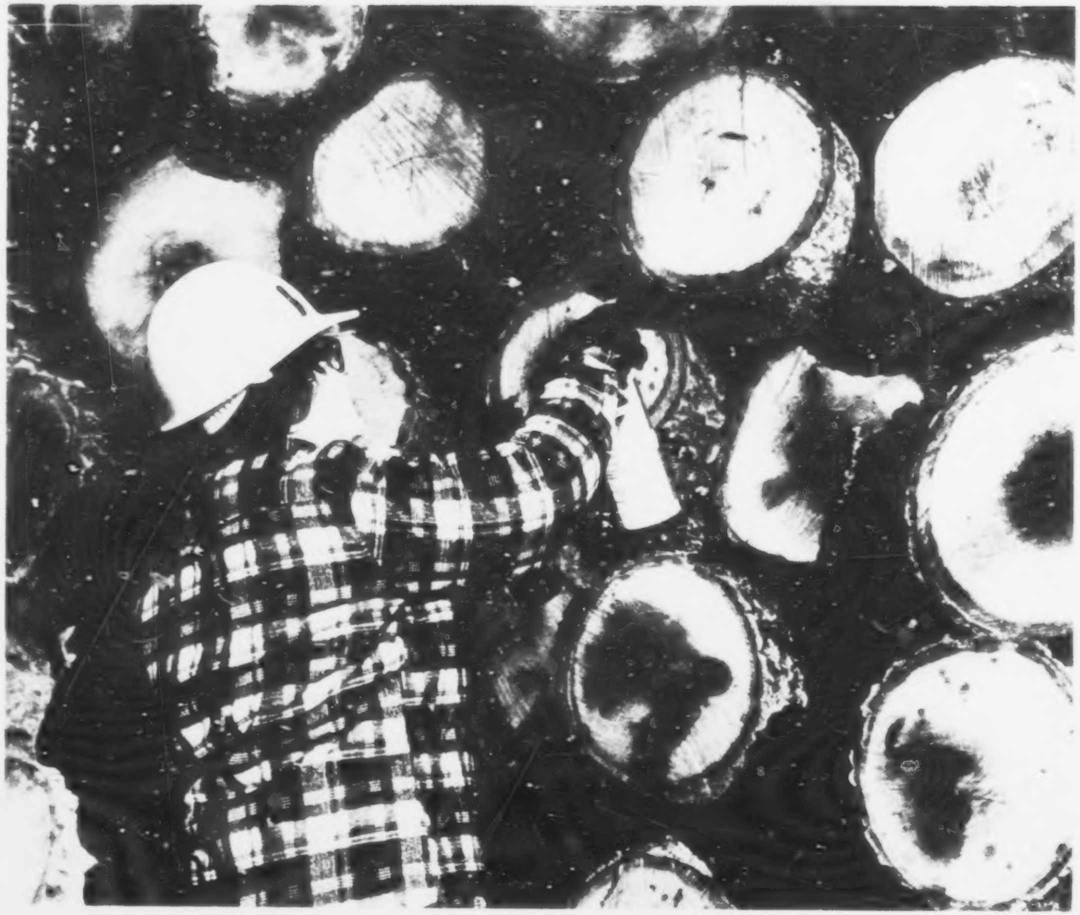


A Simple Method for Identifying Oak Logs

Red oak logs bound for Europe must be fumigated to prevent the possible spread of oak wilt disease, and, until recently, the same expensive treatment was required for white oak logs even though they are not normally carriers of the disease. The reason? There was no easy foolproof method for separating logs of the two species. A commission of the European Common Market has decided that white oaks could be exempted from fumigation if a quick and accurate test for separating red from white oak logs is developed.

Scientists in the Forest Products Laboratory's Center for Wood Anatomy Research have developed and demonstrated such a test. It is cheap and very accurate. A 10-percent aqueous solution of sodium nitrite must be sprayed on freshly exposed heartwood. The solution turns a yellowish brown on red oak heartwood and dark bluish black on white oak heartwood. The test works equally well on green or dried oak wood. Low temperatures slow the reaction time but not the resulting color.

If the test is accepted by the Common Market, only red oak logs will require fumigation. As a result, costs of white oak logs from the United States may decline in European markets, making them more competitive.

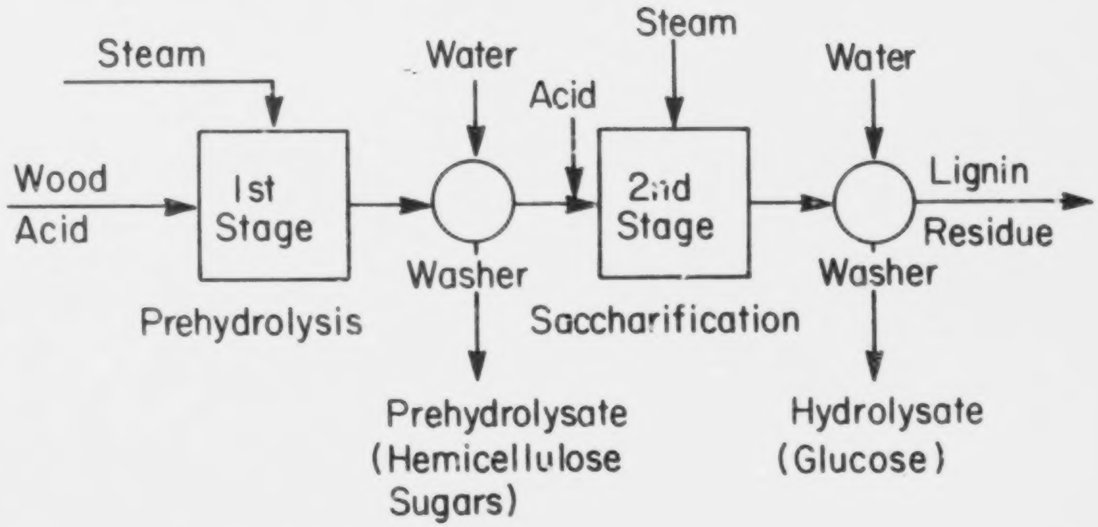


The color change in a sodium nitrite solution sprayed on logs separates red from white oaks.

Cellulose and hemicellulose, two primary constituents of wood, consist of sugar molecules bonded end to end. These bonds can be broken and the sugars extracted in a process called hydrolysis. Because sugars and the chemicals that can be made from them are more valuable than raw wood, conversion of wood to sugar on a commercial scale depends primarily upon the cost of hydrolysis.

Chemists and chemical engineers at the Forest Products Laboratory, working in cooperation with the Tennessee Valley Authority (TVA), have found ways to significantly reduce the cost of wood hydrolysis. They have developed a two-stage process in which the concentration of sulfuric acid is reduced, the liquid-to-solid ratio is reduced, temperatures are increased, and feedstock moisture content is controlled. In comparison with conventional technology, the new process reduces energy requirements by about 40 percent and equipment costs by about 25 percent.

TVA is developing the process through the pilot-plant stage with an eye toward utilization of surplus red oak in its territory. The United States has a large excess of low-grade hardwoods, which could be converted to ethyl alcohol, furfural, and other basic chemicals after hydrolysis.



Two-stage hydrolysis of wood.

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Yarding is the movement of logs from the points where trees are felled to a place where they can be loaded onto trucks and hauled to a mill. In the steep terrain of the Pacific Northwest, yarding is often done with skylines--cable systems that lift the logs off the ground and move them 1,000 feet or more to a landing. Movement of logs in this manner reduces disturbance of the site, and increases in yarding distance decrease the length of road that must be constructed to log a given site. Movement and setup of the skyline yarding system around the logged area is quite expensive, however, and efficient use of the system can make the difference between profit and loss for the logger.

Optimum use of a skyline logging system requires complex computations that depend upon the locations of roads and the distribution of timber on the logging site. Engineers at the Pacific Northwest Station decided that such work was best done with a computer, and they developed a computer model called SIMYAR (SIMulated YARding) to assist in the process. SIMYAR shows how costs vary with important factors that affect production time. Thus, it helps the logger to assure cost-effective yarding. SIMYAR is compatible with a computer-aided design package called PLANS (Preliminary Logging ANalysis System), which is already in use in private industry, the USDA Forest Service, and some State universities.

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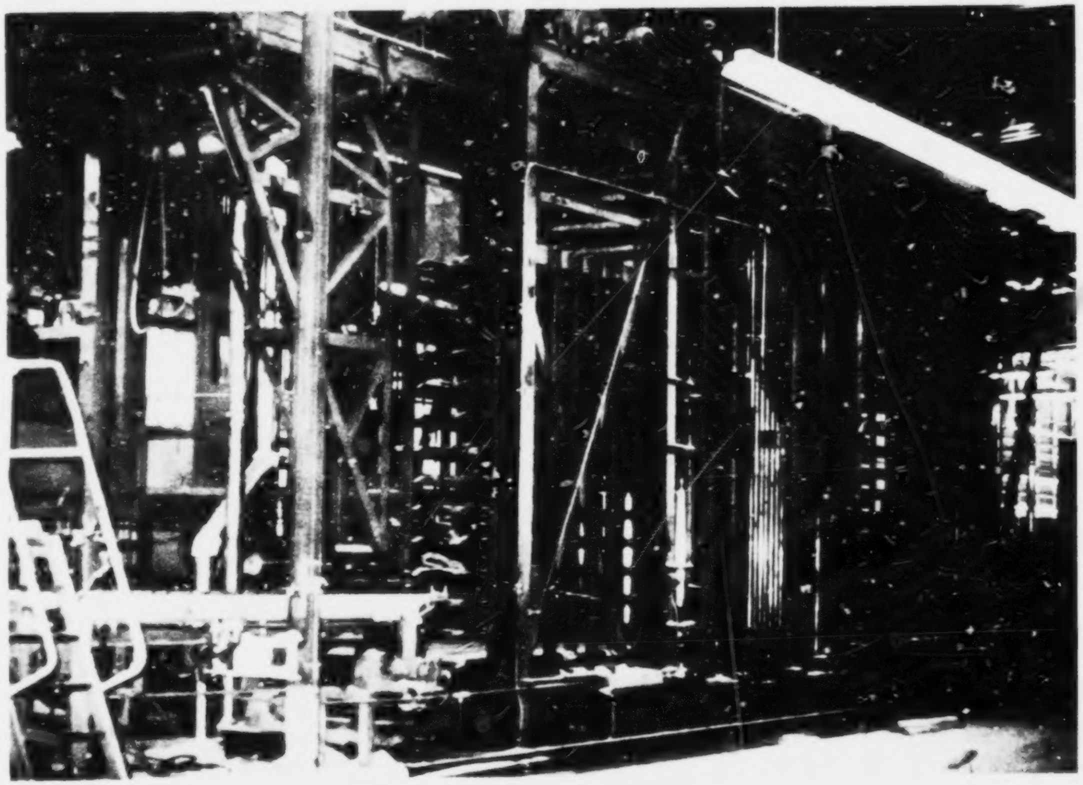
Particle Board From Black Hills Ponderosa Pine Residues

A $25 million particle board plant nearing completion in South Dakota will produce 20 to 25 carloads of particle board per week from Black Hills sawmill residues. Forest Service research established both the technical feasibility and economic potential of such a plant.

The facility, which will employ 250 people, will use about 30 truckloads of residues per day, collected from 11 area sawmills. The particle board will be made from a mixture of 50 percent sawdust, 30 percent planer shavings, and 20 percent chips from slabs and edgings. The board will ultimately be used in kitchen cabinets and vanities.

Researchers from the Rocky Mountain Station, concerned about better utilization of ponderosa pine in the Black Hills, established that several types of interior and exterior particle board could be made from ponderosa pine residues. They also showed that low freight rates from the Black Hills to the Midwest would contribute to economic viability of a large particle board plant, even with "soft" markets.

Most of the sawdust and planer shavings intended for the new plant were previously burned at the sawmills.



A multiple-opening press like this will transform Black Hills sawmill residues into core stock for kitchen cabinets.

A Sticky Wastepaper Problem Is Solved

Nonwettable adhesive contaminants, which papermakers call "stickies," have been a major obstacle in wastepaper recycling. Sometimes they adhere to papermaking equipment, and sometimes they show up as undesirable spots on the paper product. Scientists at the Forest Products Laboratory, working in cooperation with the University of Wisconsin, have developed a device that removes the stickies from wastepaper.

At the heart of the new device is a metal disk that spins at high speeds and separates particles based on size, density, and wettability differences. Stickies are about the same size and weight as pulp fibers, but they are not wettable and the spinning disk is able to separate them out on this basis.

The unique ability of this device to separate out stickies while making size and density separations is highly important to the paper industry. If a papermill's capacity must be expanded, adding recycling equipment is less expensive than adding a new pulpmill. Recycling of wastepaper has the added advantage of extending the Nation's timber supply by recovering wood fiber, most of which is now being placed in sanitary landfills.

A smooth metal disk spinning at high speed separates particles on the basis of size, density, and wettability.

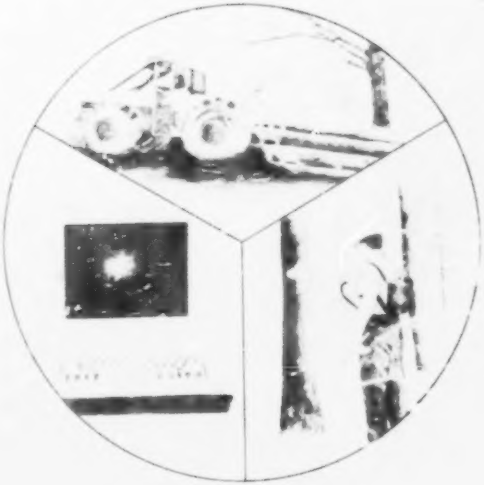
Computer Programs for Timber Cruisers

Computers and computer terminals are turning up in the offices of forest managers because these machines promise to reduce costs. Conversion of measurements by timber cruisers into estimated volumes of various products on forest tracts is a frequent task for forest managers. The only thing preventing forest managers from doing this work by computer has been a lack of satisfactory programs. Now the Southeastern Station has developed such programs for use on the major tree species in that region.

These programs estimate weights as well as volumes of products of interest, and totals are provided for entire tracts or on a per-acre basis. The user is asked questions about the tract of interest, the cruiser, and certain characteristics of the cruise. Then the user must enter the cruise tally. Commercially important species can be entered individually or as major species groups like hard hardwoods and soft hardwoods. A maximum of six species or species groups can be entered for each cruise. The programs can be used for trees from 1 to 40 inches in diameter at breast height and from 10 to 140 feet tall. Tree counts may be entered by 1- or 2-inch diameter classes and by total height or height to a 4-inch top in 5- or 10-foot intervals.

These programs are available in two forms. One version is designed for use on microcomputers, and the other is for entry on a mainframe that can be accessed at distant points by terminals.

The programs are already being used by forestry consultants, industrial foresters, and State and Federal foresters.



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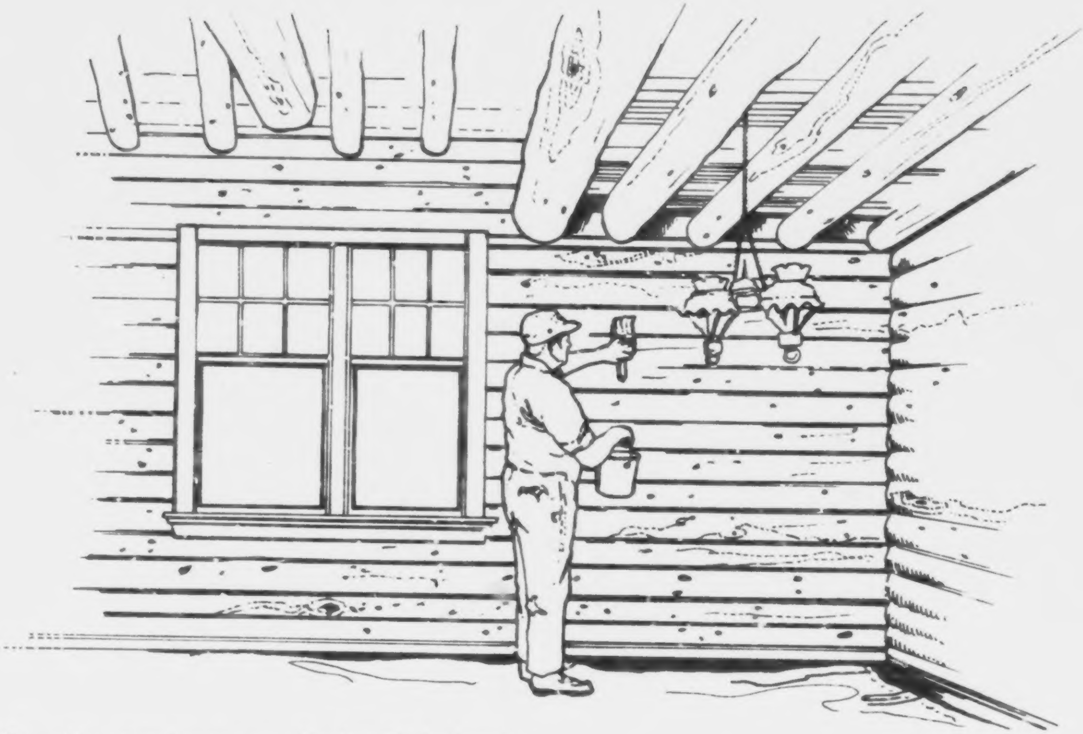
Coatings Reduce Exposure to Pentachlorophenol Vapors

The wood preservative pentachlorophenol is not currently recommended for use in building interiors, and concerns have arisen about possible health effects associated with exposure to airborne vapors often found in buildings where pentachlorophenol-treated wood has been improperly used in the interior parts.

Scientists at the Forest Products Laboratory and at Mississippi State University have identified commercially available coatings that eliminate pentachlorophenol vapors and yet are easy to apply and esthetically pleasing. Sophisticated scientific techniques were used to evaluate paints, varnishes, and other coatings for their ability to reduce or totally contain vapors emanating from pentachlorophenol-treated wood. Such coatings could eliminate the potential health hazards resulting from the use of these important wood preservatives.

Results have been published in a scientific journal and summarized in a user-oriented bulletin. This information is useful to homeowners, farmers, and others needing to reduce the level of pentachlorophenol vapors in their buildings without having to replace the treated wood.



Pentachlorophenol vapors are often found in log homes where the preservative was applied to interior wood surfaces.

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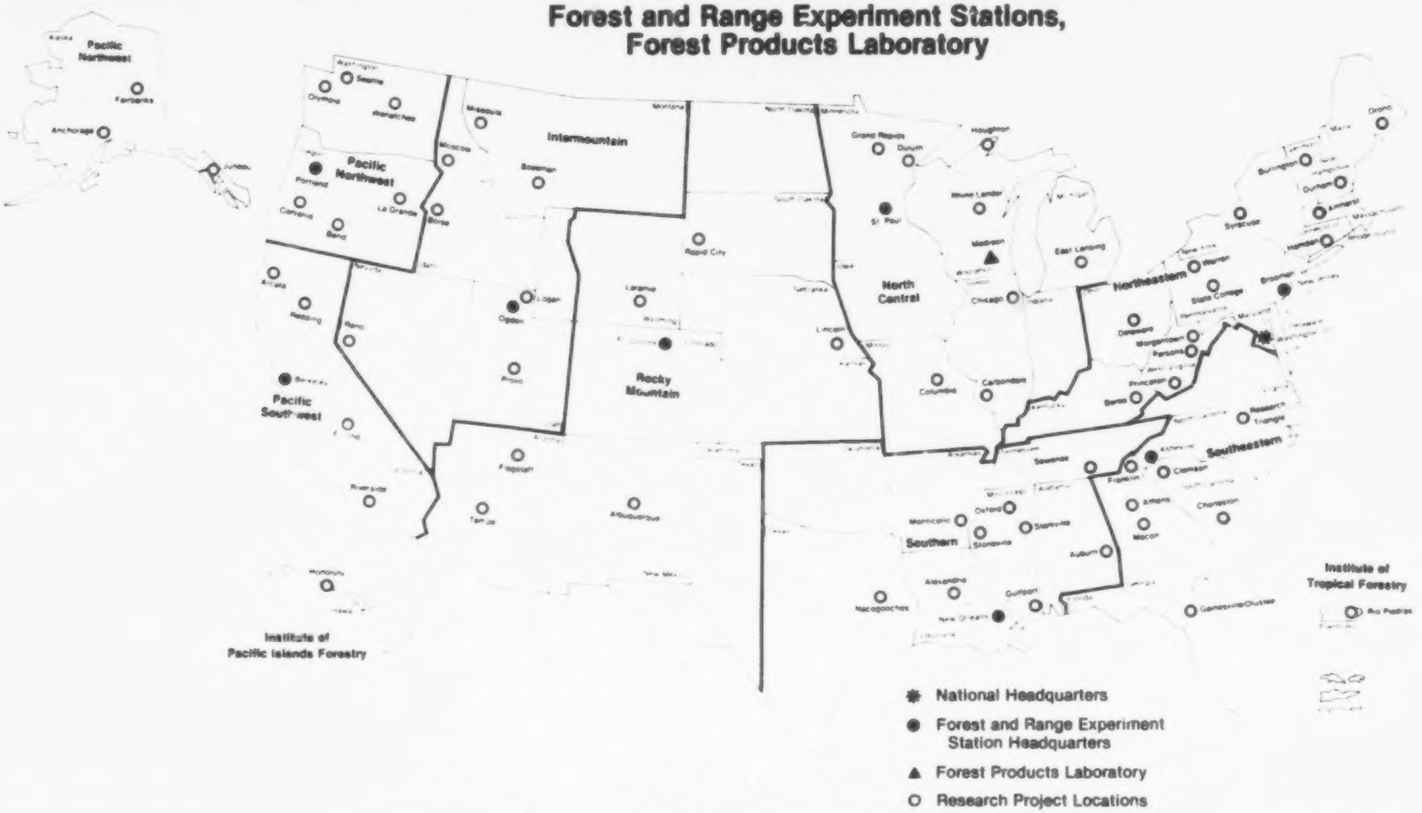
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